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FINAL REPORT

STATUS AND MANAGEMENT OF BATS IN GEORGIA BRIDGES

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16. Abstract: During a period spanning August 2003 through April 2005, this research effort focused upon a random sample of 540 bridges located in 136 Georgia counties. Within this sample, 55 bridges were identified as currently or previously occupied by roosting bats. Numerous bridge construction and surrounding habitat characteristics of roost and non-roost bridges were compared in an effort to identify bat roosting preferences. The findings replicated previous studies by confirming the importance of bridges as bat roost habitats, especially for maternity colonies. The authors recommended that the GDOT conduct maintenance and construction activities on bridges that will support existing and future bat use whenever possible. It further was recommended that, when demolition of a roost bridge is required, alternative roosting habitat, e.g., bat houses, should be provided in order to avoid displacing established bat colonies.

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Final Report

STATUS AND MANAGEMENT OF BATS IN GEORGIA BRIDGES

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INTRODUCTION

Bats are a unique and beneficial component of the fauna of the world. Some species of bats are pollinators or seed dispersers, responsible for the abundance and distribution of many types of plants. Others feed upon frogs and fish, or even scorpions and centipedes. In the U.S., bats are best known for their insect diet. According to Bat Conservation International (BCI), a single Little Brown Bat can consume up to 1,000 mosquito-sized insects in one hour. The 20 million Mexican Free-Tailed Bats that roost in Texas’s Bracken Cave eat 250 tons of insects each night. A typical colony of 150 Big Brown Bats in the Midwest can consume 38,000 cucumber beetles, 16,000 June bugs, 19,000 stinkbugs, and 50,000 leafhoppers in one season (Tuttle, 1988; Whitaker, 1993; McCracken and Gustin, 1987). The large quantity of insects consumed by bats makes them essential in the control of agricultural crop pests. Those 38,000 cucumber beetles can lay enough eggs to produce 33 million of their crop-destroying larvae in one summer (Whitaker, 1995).

Bats play a critical role in ecosystem health and insect pest control. Unfortunately, more than half of the 45 species of bats in America are endangered or declining in numbers at a rate sufficient to warrant serious concern (Keeley and Tuttle, 1999). These declining populations are a result of a number of factors, most critically the disappearance of satisfactory habitat for bats, including their natural roosts. Roosts are a vital habitat component for bats, affording protection from weather and predators, providing a place for giving birth, rearing young, mating, and hibernation (Kunz, 1982; Altringham, 1996). Natural roosts such as trees and snags are disappearing as forests are cleared to accommodate growth of human communities and the need for lumber. Other roosts such as cliffs and rock outcroppings are being damaged or completely destroyed as a result of building and road construction. Caves, which also provide important locations for bat hibernacula, are often disturbed during recreational use.

As a consequence of natural roost loss, bridges and culverts throughout the U.S. are becoming increasingly important as roosting alternatives to bats. In a survey of 2,421 nationwide bridges and culverts conducted by BCI in the late 90's, 925 (38.2%) highway structures were found to be used as roosts. Of those highway structures used as roosts, 211 (22.8%) were used as day roosts suitable for rest, rearing of young, and hibernation (Keeley and Tuttle, 1999). Of all mammals, bats have the largest surface area to body mass ratio, meaning that greater energy must be expended to maintain body temperatures. Sun-warmed bridges can provide the thermal requirements necessary to facilitate energy conservation and rearing of young (Keeley and Tuttle, 1999). During the summer months, sun-exposed bridges act as thermal sinks, often achieving and holding temperatures above the ambient average for most of the 24-hour cycle. Night-roosting bats are believed to be attracted to bridges that provide protected roosts and have a large thermal mass that remains warm at night (Keeley and Tuttle, 1999). This preliminary study conducted by BCI clearly illustrates that bridges and culverts used as roosts, particularly day roosts, must possess certain characteristics to attract bats, otherwise all bridges would support bat populations.

The purpose of this study was to conduct a survey of bridges throughout Georgia to provide valuable information regarding the specific structures being utilized as bat roosts, as well as the characteristics that make a bridge a suitable roost site. In addition, we developed a management plan for the GDOT outlining procedures for assessing the presence of bats in bridges, completing routine inspection and maintenance tasks while minimizing disturbance to the bats, and recommending bridge designs that incorporate roost features preferred by bats. This management plan also identifies ways to preserve existing or potential roosting opportunities in bridges that are scheduled for repair or demolition.

STUDY DESIGN AND METHOD

Bridge Selection

Georgia is divided into seven GDOT districts, which encompass all 159 counties of the state. As many counties as possible within each district were selected for survey work, though it was never our intent to survey bridges in every county. In order to randomly select the bridges, and hence those regions of each district to be surveyed, a map of the state was divided into 48 equally-sized squares (sections). Each section was then further divided into 36 equally-sized squares, which were numbered 1 through 36 accordingly. Using a random number generator, 12 numbers were selected from each section. These randomly selected numbers corresponded with those squares within each section that were surveyed for bridges.

At least one bridge survey per randomly selected square was attempted. The selection of the exact bridges to be surveyed was based upon a GIS map, provided by GDOT, which showed the GDOT bridges located in those areas. Sometimes, selected bridges were difficult to locate because the less-dominant roads as shown on the GIS map could not be located in the field, or because bridge locations as shown on the GIS map were unclear. At other times a selected bridge could not be surveyed because of hazardous conditions at the bridge (e.g., excessive traffic, shoulder of road too narrow for safe parking, impeded access to the underside of the bridge, presence of alligators).

As established in the first project planning meeting with the GDOT in early 2003, the safety of the investigators and field assistants was of primary concern. GDOT and team members from Columbus State University (CSU) agreed that, in order to limit liability issues for the GDOT and CSU, no unnecessary risks would be taken when conducting surveys of bridges. When a selected bridge could not be located in the field, or when a survey could not be conducted safely, then additional bridges were surveyed in nearby randomly selected areas.

The state was also divided into natural regions and data collection began in the more northerly portion of the state in August 2003 before any migrations began. The southern portion of the state was evaluated next, to coincide with earliest return of some winter migrators. As the project progressed, regions of the state were scheduled for evaluation based upon time of year, weather conditions, and availability of lodging facilities.

Data Collection

We evaluated each selected bridge for evidence of bats. Hand-held spotlights and binoculars aided in the visual observation of individuals, guano piles located on bridge beams or on the ground, guano and urine staining on the beams and inside crevices, and concrete discoloration caused by the body oils of clustered bats (See Figures 1 to 4 for examples of such visual evidence.)

Figure 1. Dr. Art Cleveland of Columbus State University and Michelle Smith (Project Assistant) use a spotlight to peer into a downspout where a bat is roosting. Burke County, Georgia. Photo by Jennifer Jackson. March 2004.

Figure 2. Guano from bats roosting in the open crevice accumulates atop a transverse beam. Sumter County, Georgia. Photo by Jennifer Jackson. January 2005.

Figure 3. Guano and urine has stained the crevices and the transverse beam on this Lamar County, Georgia bridge. Photo by Jennifer Jackson. June 2004.

Figure 4. Roosting bats have stained the parallel beams on this bridge with body oils. Stewart County, Georgia. Photo by Jennifer Jackson. March 2004.

A Peterson Bat Detector was employed in detecting bat vocalizations; however, if bat numbers were sufficient, it was not difficult to hear the bats vocalizing without the detector. In addition, any odors typically indicative of roosting bats were noted. For example, Mexican Free-tailed Bats (*Tadarida brasiliensis*), a common bridge-dwelling bat species, exude a very recognizable musty odor.

If bats or bat evidence were observed at a bridge, the number and location of separate roosts (if known) were recorded and attempts were made to determine the type of roost present—day roost, night roost or maternity roost. To assess fully the presence or absence of bats in every crevice or along every beam of each bridge was not always possible, especially when the bridge spanned a large waterway, making access to certain portions of the bridge without a boat or rappelling equipment impossible. In such cases, we relied on observation of any staining or smears of guano on structural components located in inaccessible areas.

For each bridge surveyed during the study, we evaluated the structure design, structure materials (concrete, steel, wood), and the presence of open crevices or other features that could provide suitable roosting habitat. We recorded the date of each bridge’s construction, if known, and recorded GPS coordinate and elevation data. We also evaluated the surrounding habitat in the immediate vicinity of each bridge, recording the presence of residential or commercial developments, agricultural and ranching activities, woodlands, grasslands, and/or woodland/riparian areas (See Figures 5 through 9.)

Figure 5. Commercial area near a Dekalb County, Georgia bridge. Photo by Jennifer Jackson. June 2004.

Figure 6. Ranching activities dominate the landscape surrounding this bridge in Wilkes County, Georgia. Photo by Jennifer Jackson. June 2004.

Figure 7. Woodlands surround this bridge in Lamar County, Georgia. Photo by Jennifer Jackson. June 2004.

Figure 8. Grasses dominate the landscape surrounding this Georgia bridge in McIntosh County. Photo by Jennifer Jackson. December 2004.

Figure 9. Chattooga County bridge situated in a woodlands/riparian area. Photo by Jennifer Jackson. May 2004.

Finally, conditions under each bridge were evaluated, including the presence of bare ground, flowing or standing water, roadways (e.g. 2-lane, 4-lane, dirt road), railroads, and the existence of vegetation that might impede the flyways of bats (See Figures 10 through 14.)

Figure 10. Bill Jackson (project assistant) records data during this bridge survey. This bridge spans mostly bare ground. Photo by Jennifer Jackson. April 2005.

Figure 11. This bridge spans flowing water in Pike County, Georgia. Photo by Jennifer Jackson. June 2004.

Figure 12. This Troup County bridge spans two lanes of Highway 85 in Georgia. April 2004.

Figure 13. A railroad track runs underneath this bridge located in Paulding County, Georgia. May 2004.

Figure 14. Thick vegetation blocks bat flight paths on the ends of this bridge in Chattooga County, Georgia. Bats gained access to this roost bridge via openings along the bridge middle, where vegetation was not crowding the structure. May 2004.

If the bridge did not span water, the distance to the nearest water source was determined using a topographic map. Photographs were taken of each bridge, especially those serving as roost bridges. In addition to photographs of bridge construction and surrounding habitat, Photographs often were taken detailing conditions beneath the bridges, roost locations, and bat evidence.

STATISTICAL ANALYSIS AND RESULTS

We tested the hypothesis that bridge construction and habitat characteristics associated with roost bridges would differ from those associated with non-roost bridges. Much of the statistical information shown in the tables of this report consists of descriptive analysis, e.g., totals, percentages, means and standard deviations, as appropriate. In addition, inferential analyses such as the t-test were applied to determine whether the bridge construction and habitat characteristics of roost and non-roost bridges differed significantly. Significant differences that obtained between roost bridges and non-roost bridges were interpreted as indicative of selection preferences by bats.

We randomly surveyed 540 GDOT bridges in 136 counties throughout Georgia from August 2003 through April 2005 and discovered 55 roost bridges. Figure 15 shows the location of each bridge surveyed in Georgia during this study. Figure 16 shows those counties in which bridges were surveyed, highlighting 27 counties in which roost bridges were found.

Figure 15. Location of GDOT bridges surveyed in Georgia.

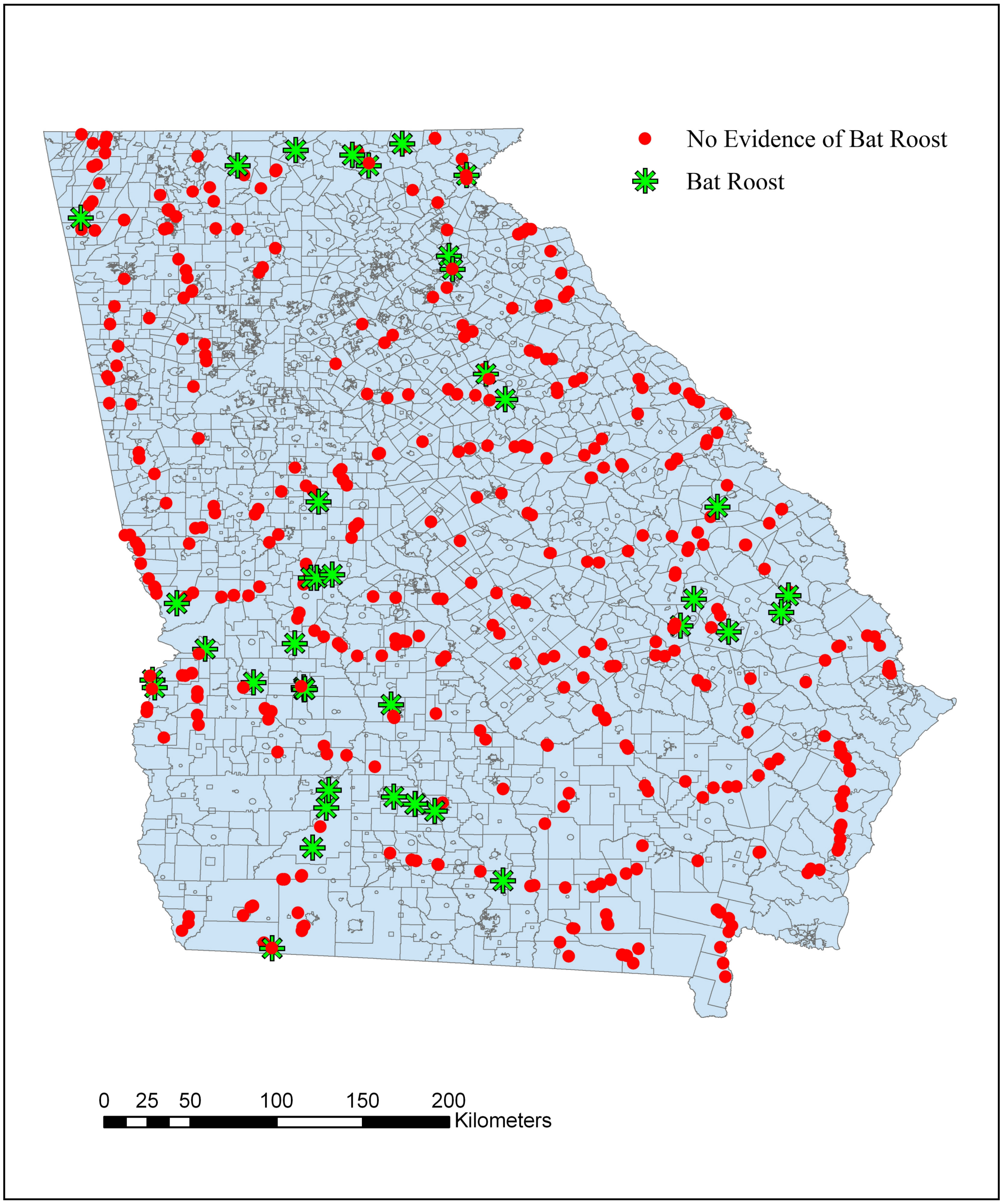
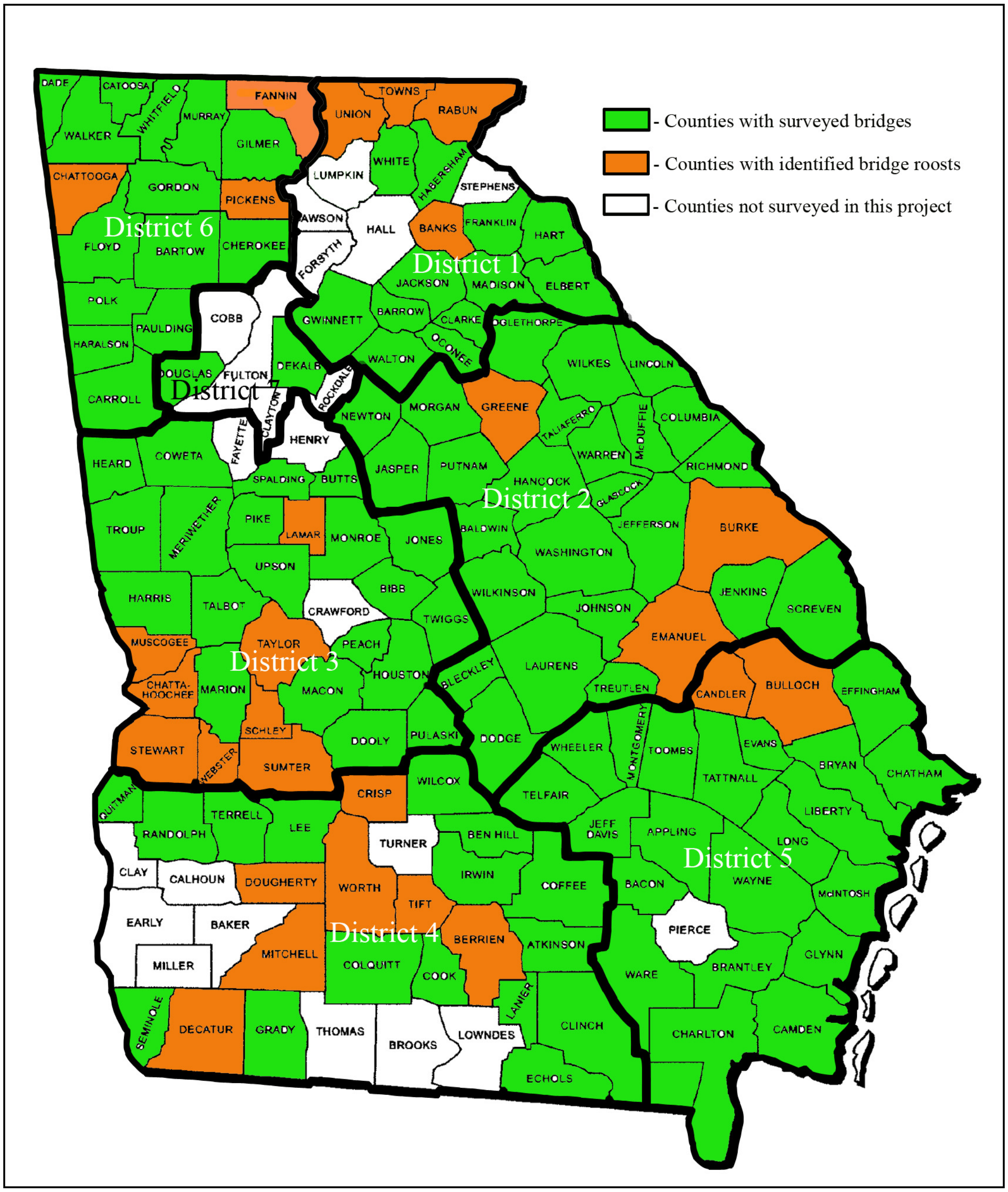


Figure 16. Counties Surveyed in Georgia.



A list of all roost and non-roost bridges with corresponding GPS coordinates can be found in Appendix A, and a table listing the number of roost and non-roost bridges per county is located in Appendix B. Bridges in each of the seven GDOT districts were surveyed, and roost bridges were found in all districts except District 7.

Evidence of Bats

When individuals were not detected visually or audibly during a survey, other evidence was taken to indicate that bats were currently using or had been using a roost bridge. For example, all 55 roost bridges displayed one or more of the following indicators: Staining from guano and urine on the beams and other structural components of the bridge underbelly, discoloration of concrete beams from body oils of clustered bats, guano piles on the ground or atop beams, and/or presence of a musty odor typical of roosting bats. Table 1 summarizes the frequency with which such bat evidence was found for each identified roost bridge. A more detailed list of the types of evidence discovered at each roost bridge is located in Appendix C.

Table 1. Summary of Evidence for Presence of Bats at Roost Bridges

Type of Evidence	Frequency	[1] % of Total Frequency (120) of Evidence	[2] % of Total # (55) of Roost Bridges
Bats Observed	10	8.33	18.18
Staining Present	47	39.17	85.45
Guano Present	47	39.17	85.45
Odor Present	8	6.67	14.55
Vocalizations Present	8	6.67	14.55
Total	120	100	

1. Percent = (Frequency/120) X 100
2. Percent = (Frequency/55) X 100

Construction Characteristics

A total of 383 (70.9%) of the surveyed bridges were constructed almost entirely of concrete; however, 154 (28.5%) of the bridges were steel I-beam and three of the bridges (0.6%) were constructed of nearly equal parts of concrete, steel, and wood materials. Of those bridges identified as roosts, 42 (76%) were primarily constructed of concrete, followed by 12 (22%) of steel I-beam design, and one (2%) roost bridge constructed of multiple materials. In comparison, 341 (nearly 63%) of the non-roost bridges were of concrete construction, 142 (23%) were steel I–beam, and two (0.37%) were a mixture of materials.

Depending on construction type, bridges have the potential for crevices—either running along the length of the bridge (parallel crevices) or above the transverse beams that support the bridge deck (transverse crevices) or both. (See Figures 17 and 18 for examples.)

Figure 17. This bat (*Myotis lucifugus*) is taking advantage of the open parallel crevices found on this bridge located in Schley County, Georgia. Photo by Jennifer Jackson. April 2004.

Figure 18. This Screven County, Georgia bridge has closed transverse crevices. Note the metal “ceiling”—a feature frequently found on surveyed bridges during this project. Photo by Jennifer Jackson. March 2004.

When a bridge is first constructed, expansion joint material is used to fill any parallel and/or transverse crevices, creating closed crevices. The crevices open as this material deteriorates over time and, in turn, the potential for use by bats increases. (See Figure 19.)

Figure 19. Fill material is falling from this bridge’s transverse crevices in Colquitt County, Georgia. Photo by Jennifer Jackson. January 2004.

In this study, 406 of the bridges surveyed had transverse crevices and only 34 were observed to have parallel crevices. Of those bridges with transverse crevices, 269 (49.8%) had open crevices. Of those bridges observed to have parallel crevices, 9 (1.7%) possessed open parallel crevices. A total of 43 roost bridges (78%) had open transverse crevices, and 4 had open parallel crevices (7.2%). Some bridges are constructed such that no crevices are formed; in the present study, 110 bridges of this type were observed. Only four of these were roost bridges. (See Figure 20 for an example of a bridge with no crevices.).

Figure 20. This arched bridge in Jackson County, Georgia had no crevices (sealed or open). Photo by Jennifer Jackson. June 2004.

Deck or “ceiling” materials of the 540 bridges surveyed in this study were concrete, corrugated steel or, occasionally, a combination of both. Fifty-four of the 55 roost bridges (98.1%) had concrete ceilings. The remaining roost bridge was constructed of both concrete and corrugated steel. None of the roost bridges had ceilings covered entirely in corrugated steel. In comparison, 383 of the 485 non-roost bridges (79.4%) had ceilings constructed solely of concrete materials. A total of 82 of the non-roost bridges (17%) had steel-covered ceilings, and 16 (3.3%) had a combination of both concrete and steel ceilings. (See Table 2 for a description of the bridge construction characteristics found in this study, including construction material, presence of open and closed crevices, and type of ceiling materials.)

Table 2. Construction Characteristics of Roost and Non-Roost Bridges

Characteristic	Characteristic Variation	Bridge Type	# Bridges	Valid N %
Construction Material	All Concrete	Roost Bridges	42	11.0%
		Non-Roost Bridges	341	89.0%
	Steel I-Beam	Roost Bridges	12	7.8%
		Non-Roost Bridges	142	92.2%
	Concrete, Wood & Steel	Roost Bridges	1	33.3%
		Non-Roost Bridges	2	66.7%
Parallel Crevices	Open	Roost Bridges	4	44.4%
		Non-Roost Bridges	5	55.6%
	Closed	Roost Bridges	3	12.0%
		Non-Roost Bridges	22	88.0%
	None	Roost Bridges	48	9.5%
		Non-Roost Bridges	456	90.5%
Transverse Crevices	Open	Roost Bridges	43	16.0%
		Non-Roost Bridges	226	84.0%
	Closed	Roost Bridges	4	2.9%
		Non-Roost Bridges	133	97.1%
	None	Roost Bridges	8	6.1%
		Non-Roost Bridges	124	93.9%
Ceiling Material	Concrete	Roost Bridges	54	12.4%
		Non-Roost Bridges	383	87.6%
	Metal	Roost Bridges	0	.0%
		Non-Roost Bridges	82	100.0%
	Both	Roost Bridges	1	5.9%
		Non-Roost Bridges	16	94.1%

Roosting Locations on Bridges

As determined from this study, suitable roosting locations on bridges include open transverse crevices, open parallel crevices, transverse and parallel beams, downspouts (openings on the lateral edges of the bridges that funnel storm water runoff), and concrete bridge decks (“ceilings”). In 43 of the 55 roost bridges (78.2%), only one roosting location type was used by bats. For 12 of the roost bridges (3.6%), bats utilized a combination of different roosting locations at one time. For example, in a roost bridge located in Stewart County near Omaha, Georgia, bats were roosting in transverse crevices, along parallel beams, and in downspouts (See Figures 21, 22 and 23.)

Figure 21. This bridge near Omaha, Georgia holds an estimated 2000 bats (mostly *Tadarida brasiliensis*), who use this roost primarily for rearing young. Stewart County. Photo by Jennifer Jackson. March 2004.

Figure 22. Piles of bat guano dropped beneath the maternity roost bridge located near Omaha, Georgia in Stewart County. Photo by Jennifer Jackson. June 2004.

Figure 23. Under the guidance of Dr. Art Cleveland, David Brooks (Project Assistant) delves into an open crevice of this maternity roost bridge located in Stewart County. He was delicately retrieving bat individuals in order to determine species. Photo by Jennifer Jackson. May 2004.

Table 3 summarizes the roosting locations selected by bats on roost bridges in this study.

Table 3. Summary of Bridge Roost Locations

Bridge Roost Location	[1] # Bridges	Valid N %
Transverse Crevices	33 (8)	60.0%
Parallel Crevices	1 (2)	1.8%
Parallel Beams	7 (9)	12.7%
Downspouts	1 (1)	1.8%
Bridge Ceiling	0 (1)	.0%
Transverse Beam	1 (4)	1.8%
Combination	12	21.8%
Total	55	100.0%

1. The number shown in parentheses is the number of additional roost bridges with the indicated roost location type in combination with other roost location types.

Bats were found roosting in open transverse crevices of 41 roost bridges (74.5%). Sixteen roost bridges (29.1%) had evidence of bats roosting along the parallel beams running under the deck. In all cases, these parallel beams were constructed of concrete. Five roost bridges (9.1%) had bats roosting on the transverse beams. Three roost bridges (5.5%) had open parallel crevices serving as bat roosts. Downspouts were found to house bats on two roost bridges (3.6%); in both instances, the downspouts were blocked from the top by bridge resurfacing material or debris, and for one of these bridges, downspouts were the only roosting locations since crevices were not present. We observed a bat hanging from the bottom side of the deck (“ceiling”) on one roost bridge (1.8 %), though this bridge also had a parallel beam in use by bats. Figures 24 through 27 show several types of roost locations found on the roost bridges during this study.

Figure 24. Bats roosting in an open transverse crevice of a Lamar County, Georgia bridge. Photo by Jennifer Jackson. June 2004.

Figure 25. A bat (*Myotis lucifugus*) has found a good roosting location in this open parallel crevice on a bridge in Schley County, Georgia. Photo by Jennifer Jackson. April 2004.

Figure 26. Bats were roosting in the downspouts of this Burke County, Georgia bridge. Photo by Jennifer Jackson. March 2004.

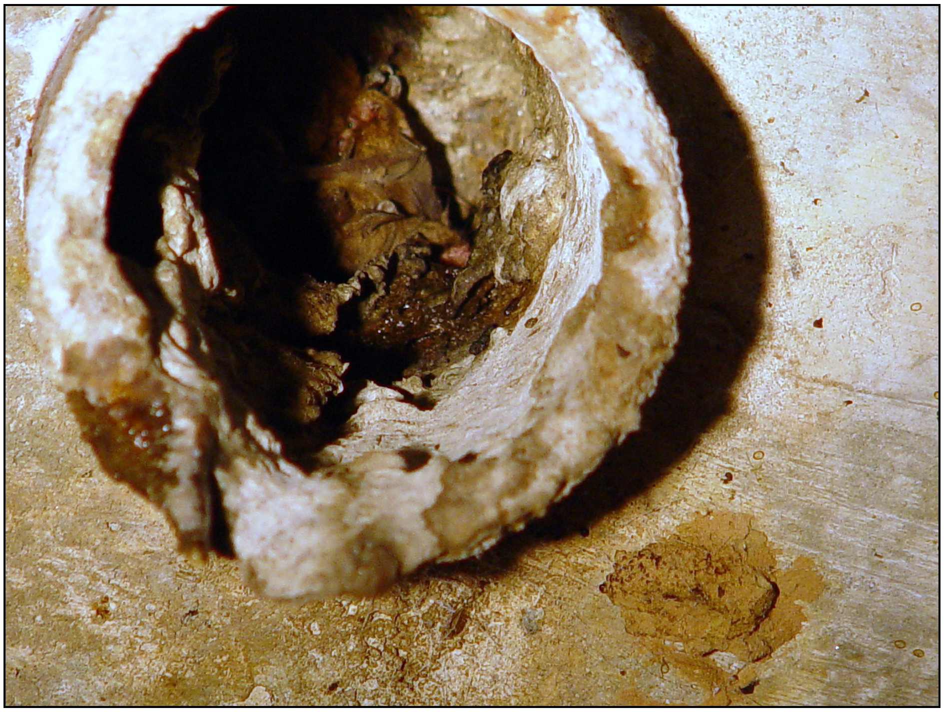


Figure 27. This bat (*Myotis lucifugus*) is hanging from the bridge's "ceiling" near a parallel beam in Chattooga County, Georgia. May 2004. Photo by Jennifer Jackson. May 2004.

The total number of roost sites on each roost bridge that were being used by bats can be found in Appendix D. Please note that, as mentioned earlier in this report, it was not always possible to access all parts of a bridge due to obstacles such as large waterways running under a bridge; therefore, the total number and type of roosting locations per roost bridge might be under-represented.

Habitat Conditions Surrounding Roost Bridges

The most common habitat variables associated with roost bridges were areas dominated by a woodlands/riparian habitat mix, though a significant number of roost bridges were in close proximity to commercial and/or residential areas. No roost bridges were found in District 7, which is a highly urban area. Table 4 details the number of roost bridges and non-roost bridges in the immediate vicinity of the habitat variables selected for evaluation in this study: Residential, agricultural, grasslands, ranching, woodlands, woodlands/riparian, and commercial.

Table 4. Habitat Conditions Surrounding Roost and Non-Roost Bridges

Habitat Area	Bridge Type	# Bridges	Valid N %
Residential	Roost Bridges	27	15.1%
	Non-Roost Bridges	152	84.9%
Agricultural	Roost Bridges	7	9.7%
	Non-Roost Bridges	65	90.3%
Grasslands	Roost Bridges	0	.0%
	Non-Roost Bridges	2	100.0%
Ranching	Roost Bridges	2	3.6%
	Non-Roost Bridges	53	96.4%
Woodlands	Roost Bridges	4	4.8%
	Non-Roost Bridges	80	95.2%
Woodlands/Riparian	Roost Bridges	46	10.8%
	Non-Roost Bridges	380	89.2%
Commercial	Roost Bridges	25	15.5%
	Non-Roost Bridges	136	84.5%

Each habitat variable existed alone or in combination with others. In addition to simply noting the presence of a habitat type, efforts were made to estimate the percentage of a bridge’s surroundings occupied by each habitat type. In other words, 0% to 100% of a bridge’s surrounding habitat might have been occupied by one habitat type or combination of types. Table 5 presents the average percentage of area occupied by each habitat type observed in proximity to roost and non-roost bridges.

Table 5. Percent of Habitat Area Surrounding Roost and Non-Roost Bridges

Habitat Area	Bridge Type	Mean	Std. Dev.	Min.	Max.	# Bridges
Residential	Roost	7.49%	12.06%	0%	45%	55
	Non-Roost	4.83%	11.48%	0%	100%	483
Agricultural	Roost	5.00%	14.75%	0%	65%	55
	Non-Roost	4.55%	14.01%	0%	82%	483
Commercial	Roost	16.55%	29.37%	0%	100%	55
	Non-Roost	10.46%	23.68%	0%	100%	483
Woodlands	Roost	.91%	3.35%	0%	15%	55
	Non-Roost	11.39%	28.45%	0%	100%	483
Grasslands	Roost	.00%	.00%	0%	0%	55
	Non-Roost	.13%	2.14%	0%	40%	483
Ranching	Roost	.55%	3.43%	0%	25%	55
	Non-Roost	4.00%	13.43%	0%	87%	483
Woodlands/ Riparian	Roost	68.78%	37.22%	0%	100%	55
	Non-Roost	64.63%	40.45%	0%	100%	483

Conditions beneath Bridges

Conditions beneath the bridges in this survey were separated into seven categories: Bare ground, open vegetation (potential flight path within 10 feet of bridge underside not blocked by vegetation), closed vegetation (flight path blocked), water (flowing, standing, or both), highway, dirt road and railroad. Combinations of conditions were evident under all 540 bridges surveyed. Table 6 lists the various conditions that were observed under the bridges during this study, as well as the total number of roost or non-roost bridges to which each condition applied.

Table 6. Conditions Beneath Roost and Non-Roost Bridges

Conditions	Bridge Type	# Bridges	Valid N %
Bare Ground	Non-Roost Bridges	40	97.6%
	Roost Bridges	1	2.4%
Open Vegetation	Non-Roost Bridges	478	89.7%
	Roost Bridges	55	10.3%
Closed Vegetation	Non-Roost Bridges	17	85.0%
	Roost Bridges	3	15.0%
Flowing Water	Non-Roost Bridges	315	91.0%
	Roost Bridges	31	9.0%
Standing Water	Non-Roost Bridges	51	79.7%
	Roost Bridges	13	20.3%
Standing and Flowing Water	Non-Roost Bridges	13	86.7%
	Roost Bridges	2	13.3%
2-Lane Highway	Non-Roost Bridges	20	90.9%
	Roost Bridges	2	9.1%
4-Land Highway	Non-Roost Bridges	36	94.7%
	Roost Bridges	2	5.3%
5-Lane Highway	Non-Roost Bridges	1	100.0%
	Roost Bridges	0	0%
6-Lane Highway	Non-Roost Bridges	5	100.0%
	Roost Bridges	0	0%
Dirt Road	Non-Roost Bridges	15	93.8%
	Roost Bridges	1	6.3%
Railroad	Non-Roost Bridges	40	88.9%
	Roost Bridges	5	11.1%

As Table 6 shows, only one of the roost bridges was located over bare ground.

Most non-roost bridges and roost bridges (a total of 533 or 89.7%) had portions of their structures considered “open” to bats in terms of flyways. Three roost bridges did have some portions of their structures blocked by vegetation, though flyways were sufficiently clear to allow roost access. In fact, each of the 55 roost bridges was associated with generally open flight paths (open vegetation) along some portion of its structure.

A total of 423 (78.3%) non-roost bridges and 51 (92.7%) roost bridges had no highway running underneath the structures. Four of the roost bridges spanned either 2-lane or 4-lane highways, and one spanned a dirt road. Most of the bridges surveyed did not cross over railroad tracks, though five roost bridges did.

Types of water sources found beneath bridges or in close proximity to bridges included rivers, creeks, lakes, intermittent pools, and swampy/marshy areas. The average distance to water for roost bridges and non-roost bridges was 0.06 km (~ 0.03 mi) and 0.23 km (~ 0.13 mi), respectively. Most of the roost bridges (N=46 or 83.6%) and most of the non-roost bridges (N=379 or 78.1%) were located directly over flowing and/or standing water. Those roost bridges (N=9) that did not span a water source were on average 0.37 km (0.23 miles) from either flowing or standing water, whereas non-roost bridges (N=106) were, on average, 1.07 km (0.66 miles) from any type of water source. The maximum distance any roost bridges were located from a water source was 1 km (0.62 miles). This is in comparison to 5 km (3.1 miles) for non-roost bridges. Tables showing total numbers of roost and non-roost bridges spanning water types (flowing, standing, or both flowing and standing), including distances to such water sources, are included in Appendix E. It is important to note that water in the form of intermittent streams or pools might exist under or in the vicinity of a bridge during part of a season, or only during "wet" years. In order to be counted as a present condition in this study, water had to be observed at the time of the bridge survey.

Elevational Data

Non-roost bridges were located at elevations ranging from approximately three feet (49 meters) above mean sea level (MSL) to approximately 1,978 feet (673 meters) above MSL. Roost bridges ranged in elevation from approximately 1 meter (143 feet) above MSL to approximately 682 meters (1,951 feet) above MSL. The mean elevations of non-roost and roost bridges were 157 meters (455 feet) and 215 meters (623 feet), respectively. Elevational data for all bridges can be found in Appendix F.

Age of Bridges

The oldest construction date for a non-roost bridge recorded during this study was 1935 and the most recent for a non-roost bridge was 2004. The oldest roost bridge was constructed in 1949, with the most recent being constructed in 1996. However, the 1996 bridge was actually an older bridge (original construction date unknown) that had been expanded and modified in 1996. Bridge remodeling activities were evident for some roost and non-roost bridges in this study; therefore, it was difficult to ascertain the true age of those bridges. That aside, the average age of non-roost bridges and roost bridges based on the recorded dates of last construction, was 29.67 years and

33.50 years, respectively. Dates of construction could not be found or were simply not recorded for 43 of the non-roost bridges, and three construction dates could not be found for three of the roost bridges. Age data for all bridges is included in Appendix G.

Bat Species using Roost Bridges

It was not always possible to determine the species of bats using the roost bridges, especially in those surveys during which no individuals were observed. Individuals were observed in only 10 of the 55 roost bridges, and when possible, were identified to species following capture or close inspection. We were able to make species determinations in five of the roost bridges in which individuals were not observed based on the presence of odor alone (Mexican Free-tailed Bats).

It is important to note that multiple species can share roosts, which was evident in this study. There were at least two roost bridges, which were positively being shared by at least two species—Mexican Free-tailed Bats (*T. brasiliensis*) and Little Brown Bats (*Myotis lucifugus*). That said, it is possible that we successfully detected bat species at a roost bridge via observation or odor, but perhaps missed other bat species at the same roost simply because individuals were not visible to us or detectable during the survey. However, when individuals were positively identified, the most common species of bridge-dwelling bats in this study was the Mexican Free-Tailed Bat (*T.*

brasiliensis), present in seven of the roost bridges. Little Brown Bats (*M. lucifugus*) were also observed in five roost bridges, and Big Brown Bats (*Eptesicus fuscus*) were observed in one roost bridge. Five roost bridges housed bats, which we were unable to positively identify by species either because the individuals flew when we approached or because the individuals were roosting in inaccessible locations. Of the 16 species of bats in Georgia, 12 (including the three species recorded in this study) are likely to use bridges as roosts (Keeley and Tuttle, 1999). Five of the bridge-dwelling species are considered rare or are listed as endangered in Georgia, though none of the species positively identified in roost bridges in this study have been assigned either status. A list of the 16 bat species in Georgia, their state/federal status, food preferences, migration and hibernation behavior, maternity roost activities, and potential for roosting in bridges is provided in two tables in Appendix H.

Because bridge surveys were conducted during daylight hours, the 10 roost bridges found to contain individuals were counted as day roosts. It is very likely that those bridges for which staining, guano, or odor were detected (minus individuals) were used as day roosts at other times of the year or as night roosts. As many as eight of the roost bridges are currently thought to be large maternity roosts during the summer months based on the number of individuals present and/or the significant amounts of staining and guano observed. However, it is possible that any of the roost bridges identified in this study are used for the rearing of young, or for that matter, as hibernacula during winter months.

Miscellaneous Data

Bridges sometimes are paired in a side-by-side fashion to accommodate multiple lanes of traffic traveling in two different directions. We discovered five such bridges that were roosts, though bat evidence was absent in the “partner” bridge located in the immediate vicinity of the identified roost bridge.

CONCLUSIONS

The data from this study suggest that bats prefer roost bridges primarily constructed of concrete materials with open crevices, which is supported by other bat studies such as those conducted by BCI (Keeley and Tuttle, 1999) and the Florida Department of Transportation (Studenroth K., Pers.Comm.). Concrete “ceilings” and beams provide suitable attachment sites for those species that will roost in the open, such as the Big Brown Bat (*E. fuscus*) and the Little Brown Bat (*M. lucifugus*). Open transverse and parallel crevices provide roosting opportunities for species that frequently select crevices, such as the Mexican Free-tailed Bat (*T. brasiliensis*) and the Little Brown Bat (*M. lucifugus*). Crevices provide protection from inclement weather and predators, and are especially important to maternity colonies in which females must leave their young to forage.

In this study, 406 of the bridges surveyed featured transverse crevices and 34 were observed to have parallel crevices. Of these bridges, almost 50% possessed open transverse crevices, and approximately 2% of the bridges possessed open parallel crevices. In comparison, 78% and 7.2% of the bridges selected as roosts by bats had open transverse crevices and open parallel crevices, respectively. This demonstrates that there exists a preference by bats for open crevices as roosting sites.

Though specific crevice measurements were not recorded in this study, previous research indicates that vertical crevices preferred by bats are 0.25 to 3 cm (0.5 to 1.25 in) wide and are at least 30 cm (12 in) deep (Keeley and Tuttle, 1999). This same BCI study also indicates that roost height is ideally 10 feet (3 m) or more above the ground. Though the results of our study generally confirm these finding, we encountered at least three roost bridges at which bats roosting on open parallel beams at a height that was within easy reach of the researchers.

In addition to open crevices, bats in this study commonly chose roosting sites on concrete parallel beams and concrete transverse beams. Bridges with steel I-Beam construction were not selected as frequently and were not suitable roosts unless crevices or other roosting features were present. No steel beams were used as roosting locations. This likely was the case because it is difficult for bats to cling to slippery metal surfaces.

Though not a common roosting location in bridges in this study, downspouts sealed from above by debris or bridge resurfacing material were utilized by bats for roosting. This was an especially important roosting option for one roost bridge in the study that had no open crevices available for bats. On that bridge, almost every closed downspout (N=16) was filled or had been filled with roosting bats.

Bridges built with corrugated steel “ceilings” were less suitable as roosts for bats. In fact, only one roost bridge had a ceiling partially covered with corrugated steel. Though 79.6% of non-roost bridges possessed a concrete ceiling, and 17% possessed a steel ceiling, 98% of roost bridges had a concrete ceiling and none had a steel-covered ceiling. (One roost bridge in the study had a ceiling covered in both concrete and steel materials.) This pattern demonstrates a definite selection preference of bats for bridges without steel-covered ceilings. It is not known why bridges with steel ceilings do not make suitable roosts since only one roost bridge was found with bats roosting on a concrete ceiling. There must be other features absent from bridges with steel ceilings, or perhaps the temperature of the bridge's underbelly is affected by the presence of a steel-covered ceiling.

The most common habitat condition surrounding both roost and non-roost bridges was the woodland/riparian habitat type. This is likely because bridges are typically constructed over flowing or standing waterways, which are numerous in Georgia. It then makes sense that if a majority of the surveyed bridges spanned water, that a majority of the roost bridges also spanned water. Following woodland/riparian habitat, roost bridges were most commonly found surrounded by residential dwellings and commercial areas. Sometimes commercial and residential areas provide additional water and food sources associated with human activity. Artificial ponds, water fountains, swimming pools, and troughs provide additional water sources. Lights associated with streets, houses, commercial buildings, and recreational facilities like parks and sports fields, often attract insects. In addition, parks, sports fields, and parking lots provide open foraging areas (personal observation, 1998–2005). Of course, it might be possible that in areas of commercial or residential development, a former ideal habitat for bats was removed, forcing bats to select an alternate roosting habitat like bridges.

In addition to the type of habitat or combination of habitats surrounding a bridge, the percentage of area occupied by each habitat type at each surveyed bridge was also evaluated. Some areas around roost bridges were 100% commercial and other roost bridge areas were as much as 45% residential. Woodland/riparian areas represented the highest average percentage of area surrounding both roost and non-roost bridges. Again, this pattern is not surprising when one considers the fact that 426 of the 540 bridges surveyed were located in close proximity to this habitat type. Of considerable interest was the finding that the mean percent of woodlands (only) present around roost bridges (0.91%) differed significantly from the mean percentage of woodlands (only) present around non-roost bridges (11.90%). In fact, the average percentage of area occupied by woodlands near roost bridges was less than that for all other habitat types except grasslands. This is likely because woodlands alone do not provide all the habitat components suitable for a roost bridge. When ideal natural habitat is not available, open areas associated with residential and commercial developments as well as open farms and ranchlands might at least provide some open foraging habitat and access to water sources.

Woodland/riparian areas are tied with water. Data from this study show that roost bridges are closer to water sources than are non-roost bridges. As mentioned earlier, most of the roost and non-roost bridges in this study were located over water. Even those roost bridges, which did not span a waterway were still closer to a water source than were non-roost bridges. Bats use water sources not just for hydration, but as potential food sources since insects are often linked to water habitats.

Roost bridges also were found more likely to span flowing or standing water rather than busy roadways, possibly because roosting bats prefer as little as disturbance as possible. There were exceptions to this rule, however. In this study, 10 roost bridges were discovered spanning active roadways and/or railroad tracks. Similarly, prior to beginning this study we visited two bridges in Florida in Spring 2003 that also were situated over a busy interstate and yet still housed thousands of Mexican Free-tailed Bats (*T. brasiliensis*).

Another salient roost bridge characteristic that emerged in this study was the presence of open flyways (not impeded by vegetation), which allow access to roosting sites on bridges. All 55 roost bridges were associated with open flyways. In addition, independent t-tests revealed that the mean elevation of non-roost and roost bridges differed significantly. Perhaps this can be explained by the fact that temperature varies directly with elevation level. This study did not address the interrelationship among temperature, elevation and roost selection by bats—an interesting pattern that must await future research for adequate clarification.

The age of a bridge and its selection as a roost were unrelated in the present study. This suggests that there are features other than the age of a bridge that bats use in selecting bridge as a roost site. In particular, our data confirmed a number of features that are associated with roost site selection: The presence of open crevices or concrete beams, proximity to water, and forage areas.

Although no roost bridges were found in District 7—a highly urban area, this finding does not necessarily indicate that bats will not inhabit bridges located in urban environments. In fact, there are numerous cases where bats inhabit bridges in heavily populated areas. For example, the Congress Avenue Bridge in Austin, Texas, is the largest urban bat colony in North America, housing up to 1.5 million bats during the summer months. In Santa Barbara County, California, seven miles southeast of Santa Maria, the Garey Bridge is home to as many as 5,700 bats. This roost bridge supports one of the largest roosting colonies of bats in southern California (Storrer, 1994). In the present study, 25 of the 55 roost bridges were surrounded by commercial development, and 27 were located in proximity to residential dwellings. In some cases, areas surrounding roost bridges were occupied entirely by commercial development. This was the case in Georgia for the towns of Albany, Barnesville and Americus, all of which have roost bridges located well within the boundaries of the town limits. We conclude, then, that failure to discover roost bridges in District 7 was not due to the presence of an urban surround. Instead, we conjecture that this failure could have been a result of chance, or possibly because the dominant bridge construction type in District 7 is not conducive to bat roosting.

We discovered side-by-side bridge pairs in which one bridge was identified as a roost and the other was not, lending further support to the hypothesis that roost bridges must possess certain characteristics preferred by bats. When comparisons were made among these pairs, the roost bridge side possessed construction elements more suitable for roosting such as open crevices and more concrete structural components.

Based on the data from this study and others like it, we conclude that bats carry out preferential selection of roost bridges based on the presence of features that typically are not present on non-roost bridges. Table 7 below provides a description of ideal roost bridge characteristics gleaned from the present data set.

Table 7. Roost Bridge Preferences of Bats

• Presence of open crevices; vertical crevices preferred by bats are 0.25 to 3 cm (0.5 to 1.25 inches) wide and are at least 30 cm (12 in) deep (Keeley and Tuttle, 1999).
• Roost height is ideally 10 feet (3 m) or more above the ground (Keeley and Tuttle, 1999).
• Presence of concrete transverse and parallel beams for roosting.
• Bridge flyway not impeded by vegetation.
• Concrete "ceiling" (underside of deck).
• Bridge spans water (or is located less than 0.62 miles (1 km) from a water source).
• Bridge located at elevation between 1 meter (143 feet) to 682 meters (1,951 feet).

In order for a bridge to be identified as a roost for bats, individual bats need not be observed or heard. Evidence, such as body oil smears and guano/urine staining, guano piles, and odor are sufficient to designate a bridge as a roost. It is important to note that if bats aren't present during an inspection, time of year might be a factor. A currently-vacant roost bridge could still be invaluable as a temporary stop-over for migrating bats, or as a summer maternity roost or winter hibernacula. As ideal habitats continue to diminish for bats, roost bridges and potential roost bridges will play an even more vital role in ensuring the future of healthy bat populations.

PROPOSED MANAGEMENT PLAN

Because roost bridges are an important habitat component for bats in Georgia, it is essential that the integrity of these roosts be maintained. Furthermore, it is important to remember that as with most wildlife species in Georgia, bats are protected by state law. According to the Department of Natural Resources, *it is illegal to intentionally capture, kill, or harm any of the sixteen species of bats found in the state*. In the two sections that follow, we recommend a protocol for instances in which necessary maintenance activities or construction modifications might endanger roosts or potential roost sites and then provide some detail on how to retrofit a bridge with a roosting habitat.

Recommended Protocol

In order to minimize contact with bats and/or prevent destruction of roosts or potential roost sites, it is strongly recommended that the protocol following be followed:

- Before any activities at a bridge take place, the bridge should be surveyed for the presence of bats. Even if individuals are not observed, evidence of bat use might still be apparent in the form of guano and urine staining, guano piles, odor or body oil smears.

- It is prudent for DNR to identify the type of roost encountered, and the species in the roost. This is especially important since some of the bat species that have the potential to use bridges or culverts are considered rare, threatened, or endangered. For example, maternity colonies of both the endangered Gray Myotis (*Myotis grisescens*) and Indiana Myotis (*Myotis sodalis*) have been discovered in bridges. Of particular note in this regard, Gray Myotis maternity colonies, each numbering in the hundreds to thousands, have been found in long concrete box culverts in three states (Keeley and Tuttle, 1999). For this reason, if a bat or colony of bats is observed using a bridge or even a culvert, Jim Ozier or the current non-game wildlife biologist serving the Department of Natural Resources—Non-game Wildlife Division should be contacted at:

Georgia DNR - Wildlife Resources Division
Nongame & Endangered Wildlife Program
116 Rum Creek Drive
Forsyth, GA 31029
(478) 994-1438.

- If DOT personnel encounter bats at a bridge, either in the structure or on the ground, they should not handle the bats. Although the incidence of rabies in wild bats is less than 0.5%, it is best to refrain from direct contact with the bats. If such contact is unavoidable, then bats should only be handled by gloved individuals.

- Maintenance activities should not be conducted during the months of March through August if at all possible since this is the time when females are bearing and rearing young.

- If maintenance activities or modifications must occur while bats are present, care should be taken to minimize the disturbance of the bats especially if it is likely a maternity colony.

- *Demolition of roost bridges must never take place between the months of March and August when females are forming maternity colonies and rearing young.* If the roost bridge is a suspected winter hibernacula as often indicated by the continuous presence of bats during the months of September through February, demolition activities should also be postponed. Guidance can be provided by the Georgia Department of Natural Resources—Non-game Wildlife Division on a case-by-case basis if questions arise regarding a particular roost bridge and proposed demolition plans.

- Even if a roost bridge is not serving a maternity colony or hibernacula, its function as a day roost for bachelor colonies or migrating bats or as a night roost for foraging bats (including females from nearby maternity roosts) has significant implications in the success of bats. This should be kept in mind when conducting maintenance activities.

- Not all roost bridges house thousands of bats, yet even a roost bridge providing habitat for a few individuals is important. This is especially true if the individuals belong to a rare, threatened or endangered species. All maintenance and demolition protocol described above might apply to even small colony sizes. The Georgia Department of Natural Resources—Non-game Wildlife Division can provide guidelines on a case-by-case basis.

- Ideally, roost bridges scheduled for demolition should be abandoned rather than demolished. If abandoning a roost bridge is not an option, the new bridge being constructed should incorporate proper dimensions for expansion joints (0.5 inches to 1.25 inches wide, and nearly 12 inches deep), or retrofitted with "bat houses" or roosting habitat.

Guidelines for Retrofitting a Bridge

Because many species of bats have a high roost fidelity, it is important to preserve those roosting opportunities provided by existing roost bridges. If a roost bridge is scheduled for demolition, and the new bridge(s) cannot be built with appropriate-sized crevices, one good alternative would be to retrofit the new bridge with a roosting habitat that will provide returning bats a replacement roost. For example, the newly built bridge near Omaha in Stewart County would be a good candidate for retrofitting, since it is known that the new bridge replaced a long-standing maternity roost bridge. Retrofitting projects are recommended even for non-roost bridges, simply to provide additional habitat for bats.

According to BCI (Keeley and Tuttle, 1999), retrofitting projects have many appealing features for habitat enhancement (See Table 8.)

Table 8. Features of Bridge Retrofitting Projects

- They are adaptable to almost any structure.
- They can be placed where they will have a high potential for success.
- They can be placed in locations that minimize disturbance from maintenance or vandalism.
- They can be sized to accommodate small or large colonies.
- They are beneficial to agriculture.
- They are inexpensive (can be constructed from recycled materials).
- They can be expanded by adding additional units if initial efforts are successful.
- They can be easily moved if necessary.

At little or no extra cost to taxpayers, bridges (and even culverts) can be retrofitted or enhanced with bat-friendly habitats which, if properly installed with quality materials, should last as long as the highway structures themselves (Keeley and Tuttle, 1999). Some salient and successful examples of this strategy include the following: Four bridges in Oregon and five bridges and two culverts in Texas with signs of bat use were retrofitted with ideal roosting habitat. All were occupied by bats within the first year. In addition to Oregon and Texas, at least additional four states also are using retrofitting projects to accommodate bats (Keeley and Tuttle, 1999).

Bridge habitat enhancement measures are being incorporated into bridge and culvert structures in other countries as well. The roost portion of one old wooden bridge in Australia was retained and incorporated into a new replacement bridge (Keeley and Tuttle, 1999). In England, roost spaces have been incorporated into bridges via special bricks and concrete bat boxes, and new bridge designs have been altered to include bat habitat components (Billington, 1997 as seen in Keeley and Tuttle, 1999).

Often, wildlife focus groups like state or regional bat working groups, university wildlife clubs, community schools, and scouting groups will become involved in such habitat improvement projects. This would be a great opportunity for GDOT to engage in public outreach, demonstrating how a state’s DOT can save on man-hours and funds typically expended for habitat improvement projects.

According to BCI, successful retrofitting projects have implemented a number of design concepts, including the Texas Bat-Abode, the Big-eared Bat-Abode and the Oregon Bridge Wedge bat roost (Kelley and Tuttle, 1999). These retrofits are designed to support day-roosting bats in bridges and culverts throughout the United States. Construction documentation and drawings for these roost habitats, created and by BCI, are located in Appendix I.

The authors of this study have provided information that is designed to assist the GDOT in their role as an integral partner in the conservation of bats. In particular, the Management Plan proposed in this report should aid GDOT in equipping bridge inspectors and bridge maintenance workers with knowledge critical for the preservation of bat populations. By providing them with the location of known roost bridges and with guidelines for effective interaction with bat roosts, GDOT will make a significant contribution to the important task of promoting ecosystem health and its related human benefits. Of equal importance, the GDOT will be better positioned to *predict* those types of bridges that can potentially serve as bat roosts and, using this information, will be better positioned to make bat-friendly construction decisions.

LITERATURE CITED

Altringham, J.D. 1996. *Bats: biology and behavior*. Oxford University Press, Oxford, Great Britain. 262 pp.

Best, T. L. and Jennings, J.B. 1997. Mammalian Species—*Myotis leibii*. *The American Society of Mammalogists,* No. 547, pp. 1-6.

Caceres, M.C. and R.M.R. Barclay. 2000. Mammalian Species—*Myotis septentrionalis*. *The American Society of Mammalogists,* No. 634, pp. 1-4.

Decher, J. and Choate, J.R. 1995. Mammalian Species—*Myotis grisescens*. *The American Society of Mammalogists,* No. 510, pp. 1-7.

Fenton, M.B. and R.M.R. Barclay. 1980. Mammalian Species—*Myotis lucifugus*. *The American Society of Mammalogist,*. No. 142, pp. 1-8.

Fujita, M.S. and T.H. Kunz. 1984. Mammalian Species—*Pipistrellus subflavus*. *The American Society of Mammalogists,* No. 228, pp. 1-6.

Jones, C. 1977. Mammalian Species—*Plecotus rafinesquii*. *The American Society of Mammalogists,* No. 69, pp. 1-4.

Jones, C. and R.W. Manning. 1989. Mammalian Species—*Myotis austroriparius*. *The American Society of Mammalogists,* No. 332, pp. 1-10.

Keeley, B. W. and M.D. Tuttle. 1999. *Bats in American Bridges*. Bat Conservation International, Inc., Austin, Texas, 41 pp.

Kunz, T. H. 1982. Mammalian Species—*Lasionycteris noctivagans*. *The American Society of Mammalogists,* No. 172, pp. 1-5.

Kunz, T.H. 1982. Roosting ecology of bats. Pages 1-55 in *Ecology of Bats*. T.H. Kunz, Editor. Plenum Press, New York, New York.

Kurta, A. and R.H. Baker. 1990. Mammalian Species—*Eptesicus fuscus*. *The American Society of Mammalogists,* No. 356, pp. 1-10.

McCracken, G.F. and M.K. Gustin. 1987. Bat mom’s daily nightmare: How can she find her offspring among millions of squealing pups? *Natural History, 96*(10), 66-73.

Shump, K.A., Jr. and A.U. Shump. 1982. Mammalian Species—*Lasiurus cinereus*. *The American Society of Mammalogists,* No. 185, pp. 1-5.

Shump, K.A., Jr. and A.U. Shump. 1982. Mammalian Species—*Lasiurus borealis*. *The American Society of Mammalogists,* No. 183, pp. 1-6.

Storrer, J.R. 1994. Characterization of the Garey Bridge Bat Roost, Santa Barbara County, California. Prepared for the Santa Barbara County Department of Public Works. 15 pp.

Thomson, C.E. 1982. Mammalian Species—*Myotis sodalis*. *The American Society of Mammalogists,* No. 163, pp. 1-5.

Tuttle, M.D. 1988. *America's Neighborhood Bats*. University of Texas Press, Austin, Texas.

Watkins, L.C. 1972. Mammalian Species—*Nycticeius humeralis*. *The American Society of Mammalogists,* No. 23, pp. 1-4.

Webster, W.D., J. K. Jones, Jr., and R. J. Baker. 1980. Mammalian Species—*Lasiurus intermedius*. *The American Society of Mammalogists*, No. 132, pp. 1-3.

Whitaker, J.O., Jr. 1993. Bats, beetles, and bugs: More big brown bats mean less agricultural pests. *Bats,* 11:23.

Whitaker, J.O., Jr. 1995. Food of the big brown bat (*Eptesicus fuscus*) from Maternity colonies in Indiana and Illinois. *American Midland Naturalist,* 134:346-360.

Wilkins, K.T. 1987. Mammalian Species—*Lasiurus seminolus*. *The American Society of Mammalogists,* No. 280, pp. 1-5.

Wilkins, K.T. 1989. Mammalian Species—*Tadarida brasiliensis*. *The American Society of Mammalogists,* No. 331, pp. 1-10.

APPENDICES

APPENDIX A. List of Roost and Non-Roost Bridges with Corresponding County and GPS Coordinates Information

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
29031304	1	1	Burke	17	2	33	1.569	82	5.255
27102003	1	1	Chattahoochee	26	3	32	17.00	84	45.64
20050104	1	1	Chattooga	27	6	34	32.13	85	24.67
37060604	1	1	Lamar	85	3	33	3.208	84	10.12
38060604	1	1	Lamar	85	3	33	3.208	84	10.12
11080803	1	1	Pickens	112	6	34	48.57	84	35.50
40040304	1	1	Schley	123	3	32	18.73	84	17.63
8110703	1	1	Stewart	128	3	32	7.288	85	2.160
15092803	1	1	Union	144	1	34	48.52	83	54.04
85010105	1	1	Webster	152	3	32	6.494	84	30.05
15061204	1	0	Banks	6	1	34	20.24	83	29.29
16061204	1	0	Banks	6	1	34	16.12	83	28.12
32012504	1	0	Berrien	10	4	31	4.430	83	12.37
12031304	1	0	Bulloch	16	5	32	33.70	81	43.00
13031304	1	0	Bulloch	16	5	32	28.48	81	45.21
14031304	1	0	Candler	21	5	32	22.38	82	1.761
15031304	1	0	Candler	21	5	32	22.38	82	1.761
28102003	1	0	Chattahoochee	26	3	32	17.00	84	45.64
22040204	1	0	Crisp	40	4	31	59.06	83	47.47
8101803	1	0	Decatur	44	4	30	43.17	84	24.67
25102003	1	0	Dougherty	47	4	31	27.29	84	7.073
26102003	1	0	Dougherty	47	4	31	27.29	84	7.073
39012504	1	0	Dougherty	47	4	31	32.80	84	6.935
40012504	1	0	Dougherty	47	4	31	32.80	84	6.935
18031304	1	0	Emanuel	53	2	32	32.60	82	12.64
19031304	1	0	Emanuel	53	2	32	24.27	82	16.08
22092803	1	0	Fannin	55	6	34	53.34	84	17.25
23092803	1	0	Fannin	55	6	34	53.34	84	17.25
22060504	1	0	Greene	66	2	33	43.25	83	17.77
24060504	1	0	Greene	66	2	33	35.29	83	11.65
39060604	1	0	Lamar	85	3	33	3.208	84	10.12
40060604	1	0	Lamar	85	3	33	3.208	84	10.12

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
21102003	1	0	Mitchell	101	4	31	14.70	84	11.97
22102003	1	0	Mitchell	101	4	31	14.70	84	11.97
6110703	1	0	Muscogee	106	3	32	31.23	84	54.52
7110703	1	0	Muscogee	106	3	32	31.23	84	54.52
10092703	1	0	Rabun	119	1	34	45.61	83	23.82
9110703	1	0	Stewart	128	3	32	4.932	85	1.513
80010105	1	0	Sumter	129	3	32	4.094	84	14.83
81010105	1	0	Sumter	129	3	32	4.297	84	14.78
83010105	1	0	Sumter	129	3	32	4.370	84	14.41
6042305	1	0	Taylor	133	3	32	39.26	84	12.57
7042305	1	0	Taylor	133	3	32	39.27	84	10.66
8042305	1	0	Taylor	133	3	32	40.18	84	5.874
27040304	1	0	Tift	137	4	31	26.29	83	33.79
28040304	1	0	Tift	137	4	31	26.29	83	33.79
29040304	1	0	Tift	137	4	31	28.42	83	39.85
30040304	1	0	Tift	137	4	31	28.42	83	39.85
2092703	1	0	Towns	139	1	34	55.39	83	43.93
3092703	1	0	Towns	139	1	34	55.39	83	43.93
20092803	1	0	Union	144	1	34	51.88	83	59.58
21092803	1	0	Union	144	1	34	51.88	83	59.58
31040304	1	0	Worth	159	4	31	28.45	83	39.98
32040304	1	0	Worth	159	4	31	28.45	83	39.98
34040304	1	0	Worth	159	4	31	30.73	83	46.59
20051504	0	0	Appling	1	5	31	35.40	82	15.17
35051604	0	0	Atkinson	2	4	31	22.27	82	59.12
21051504	0	0	Bacon	3	5	31	32.32	82	26.87
22051504	0	0	Bacon	3	5	31	34.11	82	27.82
57042505	0	0	Baldwin	5	2	32	58.91	83	3.252
58042505	0	0	Baldwin	5	2	32	59.52	83	4.476
59042505	0	0	Baldwin	5	2	33	5.069	83	12.74
60042505	0	0	Baldwin	5	2	33	4.444	83	20.49
14061204	0	0	Banks	6	1	34	28.20	83	29.08

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
17061204	0	0	Banks	6	1	34	16.12	83	28.12
3060404	0	0	Barrow	7	1	33	55.00	83	46.83
30050104	0	0	Bartow	8	6	34	19.16	84	53.94
31050104	0	0	Bartow	8	6	34	15.65	84	51.62
32050104	0	0	Bartow	8	6	34	13.27	84	51.10
33050104	0	0	Bartow	8	6	34	13.27	84	51.10
34050104	0	0	Bartow	8	6	34	9.187	84	49.63
35050104	0	0	Bartow	8	6	34	8.897	84	49.81
36050104	0	0	Bartow	8	6	34	6.959	84	52.26
38051604	0	0	Ben Hill	9	4	31	48.53	83	17.78
39031404	0	0	Bibb	11	3	32	50.80	83	25.75
40031404	0	0	Bibb	11	3	32	50.80	83	25.75
8122904	0	0	Bleckley	12	2	32	34.35	83	14.25
9122904	0	0	Bleckley	12	2	32	24.36	83	15.47
67123104	0	0	Brantley	13	5	31	13.22	81	51.79
68123104	0	0	Brantley	13	5	31	13.22	81	51.79
69123104	0	0	Brantley	13	5	31	13.16	81	52.22
70123104	0	0	Brantley	13	5	31	13.16	81	52.22
71123104	0	0	Brantley	13	5	31	10.43	82	11.27
72123104	0	0	Brantley	13	5	31	10.43	82	11.27
42123004	0	0	Bryan	15	5	32	6.470	81	37.50
11031304	0	0	Bulloch	16	5	32	34.13	81	42.81
39123004	0	0	Bulloch	16	5	32	17.85	81	26.96
40123004	0	0	Bulloch	16	5	32	17.52	81	27.51
41123004	0	0	Bulloch	16	5	32	13.21	81	31.36
3031204	0	0	Burke	17	2	32	56.28	81	48.88
4031204	0	0	Burke	17	2	33	.675	81	45.01
5031204	0	0	Burke	17	2	33	.766	81	44.93
26031304	0	0	Burke	17	2	32	53.48	82	11.37
27031304	0	0	Burke	17	2	32	58.34	82	7.233
28031304	0	0	Burke	17	2	32	58.34	82	7.233
30031304	0	0	Burke	17	2	33	8.220	82	2.155

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
31031404	0	0	Burke	17	2	32	49.61	82	9.609
15042305	0	0	Butts	18	3	33	12.41	84	3.684
16042305	0	0	Butts	18	3	33	13.04	84	2.899
17042405	0	0	Butts	18	3	33	18.19	83	51.04
66123104	0	0	Camden	20	5	31	6.806	81	36.85
16031304	0	0	Candler	21	5	32	27.44	82	4.246
17031304	0	0	Candler	21	5	32	29.33	82	5.167
4043004	0	0	Carrol	22	6	33	33.68	85	8.799
5043004	0	0	Carrol	22	6	33	33.96	85	15.06
3080703	0	0	Catoosa	23	6	34	57.04	85	16.45
4080703	0	0	Catoosa	23	6	34	57.04	85	16.45
5080703	0	0	Catoosa	23	6	34	55.48	85	16.95
6080703	0	0	Catoosa	23	6	34	55.48	85	16.95
16012404	0	0	Charlton	24	5	30	55.27	82	5.346
17012404	0	0	Charlton	24	5	30	55.27	82	5.346
18012404	0	0	Charlton	24	5	30	54.46	82	4.320
19012404	0	0	Charlton	24	5	30	54.46	82	4.320
20012404	0	0	Charlton	24	5	30	52.06	82	1.610
21012404	0	0	Charlton	24	5	30	50.22	82	.607
22012404	0	0	Charlton	24	5	30	48.26	82	1.630
23012404	0	0	Charlton	24	5	30	43.39	82	4.247
24012404	0	0	Charlton	24	5	30	38.42	82	3.388
25012404	0	0	Charlton	24	5	30	34.26	82	2.672
26123004	0	0	Chatham	25	5	32	9.206	81	10.84
27123004	0	0	Chatham	25	5	32	9.867	81	11.07
28123004	0	0	Chatham	25	5	32	10.39	81	11.23
29123004	0	0	Chatham	25	5	32	10.39	81	11.23
30123004	0	0	Chatham	25	5	32	11.05	81	11.47
31123004	0	0	Chatham	25	5	32	11.05	81	11.47
1032604	0	0	Chattahoochee	26	3	32	15.34	84	47.51
18050104	0	0	Chattooga	27	6	34	28.10	85	20.14
19050104	0	0	Chattooga	27	6	34	28.40	85	24.04

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
21050104	0	0	Chattooga	27	6	34	35.09	85	21.90
30092803	0	0	Cherokee	28	6	34	16.56	84	27.56
31092803	0	0	Cherokee	28	6	34	16.56	84	27.56
32092803	0	0	Cherokee	28	6	34	15.00	84	28.07
18060504	0	0	Clarke	29	1	33	56.38	83	21.82
19060504	0	0	Clarke	29	1	33	56.38	83	21.82
20061204	0	0	Clarke	29	1	33	58.38	83	24.82
21061204	0	0	Clarke	29	1	33	58.38	83	24.82
1012304	0	0	Clinch	32	4	30	42.96	82	29.85
2012304	0	0	Clinch	32	4	30	40.71	82	33.46
3012304	0	0	Clinch	32	4	30	40.88	82	33.61
4012304	0	0	Clinch	32	4	30	50.53	82	39.30
5012304	0	0	Clinch	32	4	30	51.27	82	39.55
9012404	0	0	Clinch	32	4	30	49.39	82	50.51
10012404	0	0	Clinch	32	4	30	49.34	82	49.99
11012404	0	0	Clinch	32	4	31	2.421	82	44.19
12012404	0	0	Clinch	32	4	31	3.337	82	41.75
13012404	0	0	Clinch	32	4	31	4.587	82	38.49
26012404	0	0	Clinch	32	4	30	38.38	82	31.49
27012504	0	0	Clinch	32	4	30	53.75	82	39.94
28012504	0	0	Clinch	32	4	31	2.134	82	52.72
30051604	0	0	Coffee	34	4	31	46.99	82	58.52
31051604	0	0	Coffee	34	4	31	46.58	82	58.28
32051604	0	0	Coffee	34	4	31	46.58	82	58.28
33051604	0	0	Coffee	34	4	31	31.67	82	51.06
34051604	0	0	Coffee	34	4	31	27.60	82	53.21
34012504	0	0	Colquitt	35	4	31	9.325	83	32.55
35012404	0	0	Colquitt	35	4	31	9.336	83	32.73
36012504	0	0	Colquitt	35	4	31	10.42	83	39.49
37012504	0	0	Colquitt	35	4	31	10.79	83	40.86
38012504	0	0	Colquitt	35	4	31	12.90	83	47.06
34042405	0	0	Columbia	36	2	33	38.55	82	18.50

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
35042405	0	0	Columbia	36	2	33	36.09	82	14.00
36042405	0	0	Columbia	36	2	33	35.13	82	12.75
37042405	0	0	Columbia	36	2	33	34.03	82	11.00
33012504	0	0	Cook	37	4	31	7.229	83	19.38
44050204	0	0	Coweta	38	3	33	22.95	84	47.64
23040204	0	0	Crisp	40	4	31	55.83	83	46.66
24040204	0	0	Crisp	40	4	31	55.38	83	46.31
25040204	0	0	Crisp	40	4	31	55.38	83	46.31
1080703	0	0	Dade	41	6	38	51.33	84	47.94
2080703	0	0	Dade	41	6	34	58.23	85	24.27
3101803	0	0	Decatur	44	4	30	56.12	84	31.34
4101803	0	0	Decatur	44	4	30	56.47	84	30.61
5101803	0	0	Decatur	44	4	30	53.43	84	33.73
6101803	0	0	Decatur	44	4	30	44.08	84	27.21
7101803	0	0	Decatur	44	4	30	44.08	84	27.21
9101803	0	0	Decatur	44	4	30	43.17	84	24.67
5060404	0	0	DeKalb	43	7	33	46.35	84	4.660
10122904	0	0	Dodge	45	2	32	21.79	83	13.38
11122904	0	0	Dodge	45	2	32	12.28	83	8.287
13040204	0	0	Dooly	46	3	32	14.62	83	57.89
14040204	0	0	Dooly	46	3	32	14.68	83	50.22
43050204	0	0	Douglas	48	7	33	39.19	84	49.29
6012404	0	0	Echols	50	4	30	41.00	82	34.99
7012404	0	0	Echols	50	4	30	40.63	82	51.66
8012404	0	0	Echols	50	4	30	45.00	82	54.37
32123004	0	0	Effingham	51	5	32	17.90	81	14.29
33123004	0	0	Effingham	51	5	32	17.90	81	14.29
34123004	0	0	Effingham	51	5	32	20.73	81	15.98
35123004	0	0	Effingham	51	5	32	20.73	81	15.98
36123004	0	0	Effingham	51	5	32	21.11	81	18.19
37123004	0	0	Effingham	51	5	32	21.11	81	18.19
38123004	0	0	Effingham	51	5	32	17.94	81	26.74

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
3061204	0	0	Elbert	52	1	34	4.437	83	.300
4061204	0	0	Elbert	52	1	34	4.543	82	58.07
5061204	0	0	Elbert	52	1	34	4.583	82	58.08
6061204	0	0	Elbert	52	1	34	7.235	82	53.12
7061204	0	0	Elbert	52	1	34	8.776	82	51.71
8061204	0	0	Elbert	52	1	34	14.75	82	53.99
20031304	0	0	Emanuel	53	2	32	39.86	82	18.46
21031304	0	0	Emanuel	53	2	32	40.72	82	18.27
22031304	0	0	Emanuel	53	2	32	47.67	82	14.54
23031304	0	0	Emanuel	53	2	32	48.46	82	14.30
24031304	0	0	Emanuel	53	2	32	48.72	82	14.17
25031304	0	0	Emanuel	53	2	32	48.72	82	14.17
21122904	0	0	Emanuel	53	2	32	23.38	82	18.94
22122904	0	0	Emanuel	53	2	32	23.58	82	18.71
23122904	0	0	Emanuel	53	2	32	23.58	82	18.71
24122904	0	0	Emanuel	53	2	32	24.07	82	18.43
25122904	0	0	Emanuel	53	2	32	24.07	82	18.43
8051504	0	0	Evans	54	5	32	7.563	81	54.08
19080803	0	0	Floyd	57	6	34	28.44	84	58.00
14043004	0	0	Floyd	57	6	34	12.91	85	10.93
15043004	0	0	Floyd	57	6	34	12.91	85	10.93
16043004	0	0	Floyd	57	6	34	31.39	85	10.10
17043004	0	0	Floyd	57	6	34	31.39	85	10.10
11061204	0	0	Franklin	59	1	34	28.06	83	4.680
12061204	0	0	Franklin	59	1	34	26.86	83	7.465
13061204	0	0	Franklin	59	1	34	27.60	83	5.870
10080703	0	0	Gilmer	61	6	34	45.05	84	33.39
24092803	0	0	Gilmer	61	6	34	47.13	84	23.27
25092803	0	0	Gilmer	61	6	34	47.13	84	23.27
26092803	0	0	Gilmer	61	6	34	46.75	84	23.50
27092803	0	0	Gilmer	61	6	34	41.33	84	28.11
52042505	0	0	Glascock	62	2	33	14.18	82	34.77

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
53042505	0	0	Glascock	62	2	33	14.09	82	35.02
54042505	0	0	Glascock	62	2	33	13.81	82	40.07
60123104	0	0	Glynn	63	5	31	17.30	81	26.73
61123104	0	0	Glynn	63	5	31	14.75	81	26.97
62123104	0	0	Glynn	63	5	31	13.73	81	27.46
63123104	0	0	Glynn	63	5	31	7.685	81	33.22
64123104	0	0	Glynn	63	5	31	7.685	81	33.22
65123104	0	0	Glynn	63	5	31	7.979	81	35.93
8080703	0	0	Gordon	64	6	34	34.63	84	56.97
12080803	0	0	Gordon	64	6	34	28.57	84	35.49
13080803	0	0	Gordon	64	6	34	28.01	84	42.22
17080803	0	0	Gordon	64	6	34	32.47	84	54.07
18080803	0	0	Gordon	64	6	34	28.78	84	57.36
27050104	0	0	Gordon	64	6	34	34.59	84	57.24
28050104	0	0	Gordon	64	6	34	34.24	84	56.79
29050104	0	0	Gordon	64	6	34	34.24	84	56.79
10101803	0	0	Grady	65	4	30	48.54	84	15.28
11101803	0	0	Grady	65	4	30	49.09	84	15.00
12101803	0	0	Grady	65	4	30	50.15	84	14.44
13101803	0	0	Grady	65	4	30	50.15	84	14.44
14101803	0	0	Grady	65	4	30	54.03	84	16.05
15101803	0	0	Grady	65	4	30	54.03	84	16.05
17102003	0	0	Grady	65	4	31	4.729	84	21.37
18102003	0	0	Grady	65	4	31	4.731	84	20.71
9060504	0	0	Greene	66	2	33	36.49	83	20.96
23060504	0	0	Greene	66	2	33	41.58	83	16.60
25060504	0	0	Greene	66	2	33	34.91	83	16.51
4060404	0	0	Gwinnett	67	1	33	58.72	83	56.33
13092703	0	0	Habersham	68	1	34	36.80	83	32.08
24042405	0	0	Hancock	70	2	33	20.04	83	8.529
25042405	0	0	Hancock	70	2	33	20.72	83	5.904
26042405	0	0	Hancock	70	2	33	20.26	83	4.686

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
27042405	0	0	Hancock	70	2	33	16.78	82	58.64
6043004	0	0	Haralson	71	6	33	41.05	85	15.73
7043004	0	0	Haralson	71	6	33	41.05	85	15.73
8043004	0	0	Haralson	71	6	33	42.43	85	16.28
9043004	0	0	Haralson	71	6	33	45.80	85	13.34
10043004	0	0	Haralson	71	6	33	51.83	85	12.81
11043004	0	0	Haralson	71	6	33	51.83	85	12.81
4040504	0	0	Harris	72	3	32	38.86	85	3.220
5040504	0	0	Harris	72	3	32	43.56	85	5.734
6040504	0	0	Harris	72	3	32	47.80	85	6.119
7040504	0	0	Harris	72	3	32	48.99	85	6.310
8040504	0	0	Harris	72	3	32	50.27	85	7.021
19040504	0	0	Harris	72	3	32	49.93	84	50.60
9061204	0	0	Hart	73	1	34	21.67	82	57.38
10061204	0	0	Hart	73	1	34	28.51	83	3.474
1043004	0	0	Heard	74	3	33	11.76	85	1.486
2043004	0	0	Heard	74	3	33	16.72	85	6.172
3043004	0	0	Heard	74	3	33	18.63	85	6.382
15040204	0	0	Houston	76	3	32	18.14	83	45.72
16040204	0	0	Houston	76	3	32	18.14	83	45.72
17040204	0	0	Houston	76	3	32	20.18	83	45.98
18040204	0	0	Houston	76	3	32	19.52	83	43.61
19040204	0	0	Houston	76	3	32	19.26	83	42.63
36051604	0	0	Irwin	77	4	31	30.45	82	9.808
37051604	0	0	Irwin	77	4	31	32.98	83	12.30
18061204	0	0	Jackson	78	1	34	10.13	83	29.85
19061204	0	0	Jackson	78	1	34	7.147	83	34.20
18042405	0	0	Jasper	79	2	33	18.39	83	50.08
19042405	0	0	Jasper	79	2	32	20.98	83	38.64
20042405	0	0	Jasper	79	2	33	21.98	83	37.49
23051504	0	0	Jeff Davis	80	5	31	45.66	82	33.19
24051504	0	0	Jeff Davis	80	5	31	46.72	82	33.76

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
25051504	0	0	Jeff Davis	80	5	31	54.68	82	40.14
32031404	0	0	Jefferson	81	2	32	52.25	82	19.40
33031404	0	0	Jefferson	81	2	32	52.48	82	28.56
48042505	0	0	Jefferson	81	2	33	16.60	82	17.85
49042505	0	0	Jefferson	81	2	33	16.60	82	17.85
50042505	0	0	Jefferson	81	2	33	14.75	82	19.71
51042505	0	0	Jefferson	81	2	33	14.75	82	19.71
1031204	0	0	Jenkins	82	2	32	49.58	81	56.20
2031204	0	0	Jenkins	82	2	32	49.58	81	56.20
6031204	0	0	Jenkins	82	2	32	49.54	81	56.43
34031404	0	0	Johnson	83	2	32	47.58	82	33.13
35031404	0	0	Johnson	83	2	32	43.92	82	42.16
36031404	0	0	Johnson	83	2	32	44.23	82	45.84
61042505	0	0	Jones	84	3	32	56.84	83	34.78
62042505	0	0	Jones	84	3	32	56.84	83	34.78
33060604	0	0	Lamar	85	3	33	8.105	84	13.90
34060604	0	0	Lamar	85	3	33	8.105	84	13.90
35060604	0	0	Lamar	85	3	33	6.458	84	11.80
36060604	0	0	Lamar	85	3	33	6.458	84	11.80
29012504	0	0	Lanier	86	4	31	2.795	83	2.438
30012504	0	0	Lanier	86	4	31	2.693	83	3.115
31012504	0	0	Lanier	86	4	31	2.618	83	3.679
6122904	0	0	Laurens	87	2	32	31.33	83	5.445
7122904	0	0	Laurens	87	2	32	32.11	83	7.862
12122904	0	0	Laurens	87	2	32	13.73	82	59.05
13122904	0	0	Laurens	87	2	32	14.59	82	56.29
36040304	0	0	Lee	88	4	31	43.51	84	1.246
37040304	0	0	Lee	88	4	31	43.91	84	7.446
38040304	0	0	Lee	88	4	31	46.55	84	8.352
43123104	0	0	Liberty	89	5	31	49.63	81	31.55
44123104	0	0	Liberty	89	5	31	46.32	81	26.83
45123104	0	0	Liberty	89	5	31	44.89	81	26.42

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
46123104	0	0	Liberty	89	5	31	44.24	81	26.07
47123104	0	0	Liberty	89	5	31	42.63	81	24.95
48123104	0	0	Liberty	89	5	31	39.47	81	23.79
49123104	0	0	Liberty	89	5	31	39.20	81	23.68
50123104	0	0	Liberty	89	5	31	39.20	81	23.68
33042405	0	0	Lincoln	90	2	33	41.59	82	29.08
11051504	0	0	Long	91	5	31	42.04	81	46.20
12051504	0	0	Long	91	5	31	42.04	81	46.20
13051504	0	0	Long	91	5	31	40.79	81	48.72
14051504	0	0	Long	91	5	31	40.79	81	48.72
9040204	0	0	Macon	94	3	32	22.70	84	11.33
10040204	0	0	Macon	94	3	32	20.74	84	8.389
11040204	0	0	Macon	94	3	32	18.65	84	3.919
12040204	0	0	Macon	94	3	32	17.57	84	2.821
1061204	0	0	Madison	95	1	34	3.702	83	9.294
2061204	0	0	Madison	95	1	34	4.149	83	.483
41040304	0	0	Marion	96	3	32	33.05	84	31.96
31042405	0	0	McDuffie	97	2	33	30.73	82	30.13
32042405	0	0	McDuffie	97	2	33	38.73	82	28.68
51123104	0	0	McIntosh	98	5	31	38.56	81	23.66
52123104	0	0	McIntosh	98	5	31	32.27	81	25.51
53123104	0	0	McIntosh	98	5	31	32.27	81	25.51
54123104	0	0	McIntosh	98	5	31	30.00	81	26.60
55123104	0	0	McIntosh	98	5	31	27.79	81	26.14
56123104	0	0	McIntosh	98	5	31	21.86	81	26.32
57123104	0	0	McIntosh	98	5	31	21.47	81	26.58
58123104	0	0	McIntosh	98	5	31	21.47	81	26.58
59123104	0	0	McIntosh	98	5	31	20.19	81	26.94
14040504	0	0	Meriwether	99	3	33	1.683	84	42.92
15040504	0	0	Meriwether	99	3	32	59.50	84	42.47
16040504	0	0	Meriwether	99	3	32	55.00	84	46.57
17040504	0	0	Meriwether	99	3	32	54.80	84	48.07

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
18040504	0	0	Meriwether	99	3	32	54.80	84	48.07
19102003	0	0	Mitchell	101	4	31	5.634	84	15.47
20102003	0	0	Mitchell	101	4	31	5.961	84	15.29
23102003	0	0	Mitchell	101	4	31	21.31	84	9.547
24102003	0	0	Mitchell	101	4	31	21.31	84	9.547
9042305	0	0	Monroe	102	3	32	51.81	83	59.72
10042305	0	0	Monroe	102	3	32	55.11	83	58.08
12042305	0	0	Monroe	102	3	33	8.219	84	1.190
13042305	0	0	Monroe	102	3	33	8.219	84	1.190
14042305	0	0	Monroe	102	3	33	9.999	84	2.409
5051504	0	0	Montgomery	103	5	32	11.49	82	36.95
8060504	0	0	Morgan	104	2	33	36.76	83	26.65
26060504	0	0	Morgan	104	2	33	38.26	83	29.43
14080803	0	0	Murray	105	6	34	37.18	84	42.84
15080803	0	0	Murray	105	6	34	41.56	84	44.13
16080803	0	0	Murray	105	6	34	40.27	84	49.49
1110703	0	0	Muscogee	106	3	32	31.37	84	53.49
2110703	0	0	Muscogee	106	3	32	31.37	84	53.49
3110703	0	0	Muscogee	106	3	32	32.42	84	52.23
4110703	0	0	Muscogee	106	3	32	33.13	84	51.50
5110703	0	0	Muscogee	106	3	32	34.50	84	49.41
1040504	0	0	Muscogee	106	3	32	34.23	85	.830
2040504	0	0	Muscogee	106	3	32	35.10	85	1.209
3040504	0	0	Muscogee	106	3	32	36.04	85	1.422
1060404	0	0	Newton	107	2	33	35.59	83	48.52
6060404	0	0	Newton	107	2	33	36.86	83	54.80
7060404	0	0	Newton	107	2	33	36.66	83	41.90
20060504	0	0	Oconee	108	1	33	54.77	83	24.30
21060504	0	0	Oconee	108	1	33	44.07	83	18.19
15060504	0	0	Oglethorpe	109	2	33	47.87	82	58.67
16060504	0	0	Oglethorpe	109	2	33	49.09	83	1.717
17060504	0	0	Oglethorpe	109	2	33	50.51	83	3.840

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
38050204	0	0	Paulding	110	6	33	54.00	84	52.66
39050204	0	0	Paulding	110	6	33	54.00	84	52.66
40050204	0	0	Paulding	110	6	33	52.51	84	45.74
41050204	0	0	Paulding	110	6	33	49.15	84	45.52
42050204	0	0	Paulding	110	6	33	47.25	84	45.03
1122804	0	0	Peach	111	3	32	33.29	83	52.91
2122804	0	0	Peach	111	3	32	32.96	83	45.86
28092803	0	0	Pickens	112	6	34	22.58	84	23.59
29092803	0	0	Pickens	112	6	34	22.58	84	23.59
29060604	0	0	Pike	114	3	33	.777	84	28.90
30060604	0	0	Pike	114	3	33	6.225	84	21.73
12043004	0	0	Polk	115	6	33	58.82	85	15.41
13043004	0	0	Polk	115	6	34	4.030	85	13.97
37050104	0	0	Polk	115	6	34	.666	85	3.132
20040204	0	0	Pulaski	116	3	32	14.42	83	30.03
21040204	0	0	Pulaski	116	3	32	13.18	83	31.55
21042405	0	0	Putnam	117	2	33	18.86	83	26.13
22042405	0	0	Putnam	117	2	33	19.85	83	22.62
23042405	0	0	Putnam	117	2	33	20.68	83	17.10
8032604	0	0	Quitman	118	4	31	58.48	85	3.073
9032604	0	0	Quitman	118	4	31	57.20	85	3.827
10032604	0	0	Quitman	118	4	31	49.16	84	58.52
5092703	0	0	Rabun	119	1	34	56.80	83	33.05
6092703	0	0	Rabun	119	1	.	.	.	.
7092703	0	0	Rabun	119	1	34	50.48	83	25.00
8092703	0	0	Rabun	119	1	34	46.63	83	23.92
9092703	0	0	Rabun	119	1	34	45.92	83	23.84
11092703	0	0	Rabun	119	1	34	45.34	83	23.80
12092703	0	0	Rabun	119	1	34	44.30	83	23.70
11032604	0	0	Randolph	120	4	31	53.15	84	47.66
12032604	0	0	Randolph	120	4	31	56.00	84	48.10
38042405	0	0	Richmond	121	2	33	30.73	82	2.453

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
39042405	0	0	Richmond	121	2	33	30.73	82	2.453
40042405	0	0	Richmond	121	2	33	30.73	82	2.453
41042505	0	0	Richmond	121	2	33	24.77	82	5.260
42042505	0	0	Richmond	121	2	33	24.77	82	5.260
43042505	0	0	Richmond	121	2	32	23.62	82	7.013
44042505	0	0	Richmond	121	2	33	22.37	82	8.338
45042505	0	0	Richmond	121	2	33	22.37	82	8.338
46042505	0	0	Richmond	121	2	33	21.30	82	8.628
47042505	0	0	Richmond	121	2	33	21.30	82	8.628
39040304	0	0	Schley	123	3	32	18.73	84	17.63
7031304	0	0	Screven	124	2	32	41.08	81	50.39
8031304	0	0	Screven	124	2	32	34.68	81	42.57
9031304	0	0	Screven	124	2	32	34.46	81	42.66
10031304	0	0	Screven	124	2	32	34.13	81	42.81
1101703	0	0	Seminole	125	4	30	53.17	84	50.79
2101703	0	0	Seminole	125	4	30	50.98	84	50.80
16101903	0	0	Seminole	125	4	30	48.58	84	52.81
31060604	0	0	Spalding	126	3	33	13.82	84	17.48
32060604	0	0	Spalding	126	3	33	13.82	84	17.48
10110703	0	0	Stewart	128	3	32	3.563	84	47.98
11110703	0	0	Stewart	128	3	32	3.563	84	47.98
2032604	0	0	Stewart	128	3	32	9.250	84	49.72
3032604	0	0	Stewart	128	3	32	9.250	84	49.72
4032604	0	0	Stewart	128	3	32	8.470	84	51.85
5032604	0	0	Stewart	128	3	32	8.601	84	52.76
6032604	0	0	Stewart	128	3	32	8.397	85	2.876
7032604	0	0	Stewart	128	3	32	4.358	85	2.223
13032604	0	0	Stewart	128	3	32	1.943	84	47.99
14032604	0	0	Stewart	128	3	32	1.943	84	47.99
82010105	0	0	Sumter	129	3	32	4.370	84	14.41
84010105	0	0	Sumter	129	3	32	5.015	84	15.57
1040204	0	0	Talbot	130	3	32	33.12	84	40.47

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
2040204	0	0	Talbot	130	3	32	33.12	84	40.47
3040204	0	0	Talbot	130	3	32	33.73	84	36.54
4040204	0	0	Talbot	130	3	32	33.73	84	36.54
5040204	0	0	Talbot	130	3	32	36.39	84	28.54
6040204	0	0	Talbot	130	3	32	36.39	84	28.54
10060504	0	0	Taliaferro	131	2	33	37.27	82	55.25
11060504	0	0	Taliaferro	131	2	33	38.71	82	55.47
6051504	0	0	Tattnall	132	5	32	6.992	82	11.26
7051504	0	0	Tattnall	132	5	32	5.517	82	8.980
9051504	0	0	Tattnall	132	5	31	58.14	81	55.18
10051504	0	0	Tattnall	132	5	31	50.84	81	55.76
7040204	0	0	Taylor	130	3	32	28.03	84	16.00
8040204	0	0	Taylor	130	3	32	26.43	84	16.69
1042305	0	0	Taylor	133	3	32	37.15	84	14.76
2042305	0	0	Taylor	133	3	32	37.15	84	14.76
5042305	0	0	Taylor	133	3	32	39.19	84	13.19
1051504	0	0	Telfair	134	5	32	4.877	82	53.16
26051504	0	0	Telfair	134	5	31	55.34	82	40.52
27051504	0	0	Telfair	134	5	31	55.34	82	40.52
28051504	0	0	Telfair	134	5	31	57.69	82	42.43
29051504	0	0	Telfair	134	5	31	57.69	82	42.43
75010105	0	0	Terrell	135	4	31	44.05	84	22.91
76010105	0	0	Terrell	135	4	31	44.05	84	22.91
77010105	0	0	Terrell	135	4	31	54.93	84	25.72
26040304	0	0	Tift	137	4	31	28.75	83	31.19
17122904	0	0	Toombs	138	5	32	19.11	82	24.41
18122904	0	0	Toombs	138	5	32	14.85	82	24.53
19122904	0	0	Toombs	138	5	32	14.54	82	21.65
20122904	0	0	Toombs	138	5	32	16.37	82	18.59
1092703	0	0	Towns	139	1	34	54.22	83	43.34
4092703	0	0	Towns	139	1	34	57.00	83	33.06
15122904	0	0	Treutlen	140	2	32	18.20	82	41.59

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
16122904	0	0	Treutlen	140	2	32	18.49	82	41.50
9040504	0	0	Troup	141	3	32	52.71	85	9.177
10040504	0	0	Troup	141	3	32	52.71	85	9.177
11040504	0	0	Troup	141	3	32	52.65	85	10.75
12040504	0	0	Troup	141	3	33	2.554	84	57.01
13040504	0	0	Troup	141	3	33	2.555	84	57.08
3122804	0	0	Twiggs	143	3	32	32.56	83	32.06
4122804	0	0	Twiggs	143	3	32	32.54	83	31.25
5122804	0	0	Twiggs	143	3	32	37.59	83	22.22
16092803	0	0	Union	144	1	34	49.21	83	54.25
17092803	0	0	Union	144	1	34	52.70	83	57.58
18092803	0	0	Union	144	1	34	52.08	83	58.96
19092803	0	0	Union	144	1	34	52.08	83	58.96
27060604	0	0	Upson	145	3	32	50.34	84	25.46
28060604	0	0	Upson	145	3	32	59.01	84	29.98
41060604	0	0	Upson	145	3	32	52.73	84	22.63
3042305	0	0	Upson	145	3	32	43.44	84	13.91
4042305	0	0	Upson	145	3	32	43.44	84	13.91
11042305	0	0	Upson	145	3	32	56.23	83	57.60
7080703	0	0	Walker	146	6	34	52.37	85	16.09
22050104	0	0	Walker	146	6	34	37.13	85	20.85
23050104	0	0	Walker	146	6	34	48.18	85	20.82
24050104	0	0	Walker	146	6	34	55.40	85	20.76
25050104	0	0	Walker	146	6	34	48.71	85	19.55
26050104	0	0	Walker	146	6	34	42.08	85	18.74
2060404	0	0	Walton	147	1	33	52.94	83	49.36
14012404	0	0	Ware	148	5	31	6.530	82	33.73
15012404	0	0	Ware	148	5	31	7.937	82	30.47
73123104	0	0	Ware	148	5	31	15.26	82	28.60
74123104	0	0	Ware	148	5	31	15.26	82	28.60
28042405	0	0	Warren	149	2	33	17.74	82	46.82
29042405	0	0	Warren	149	2	33	19.89	82	43.62

Bridge ID	Evidence of Bats Roosting	Bats Observed	County Name	County Number	GDOT District	GPS North Degrees	GPS North Minutes	GPS West Degrees	GPS West Minutes
30042405	0	0	Warren	149	2	33	22.80	82	41.24
37031404	0	0	Washington	150	2	32	46.93	82	57.03
55042505	0	0	Washington	150	2	33	10.59	82	44.47
56042505	0	0	Washington	150	2	33	10.53	82	44.75
15051504	0	0	Wayne	151	5	31	37.19	81	52.28
16051504	0	0	Wayne	151	5	31	37.19	81	52.28
17051504	0	0	Wayne	151	5	31	33.83	81	59.27
18051504	0	0	Wayne	151	5	31	33.69	82	1.918
19051504	0	0	Wayne	151	5	31	33.42	82	6.448
78010105	0	0	Webster	152	3	31	58.03	84	26.84
79010105	0	0	Webster	152	3	31	58.10	84	26.70
86010105	0	0	Webster	152	3	32	4.764	84	33.61
87010105	0	0	Webster	152	3	32	4.764	84	33.61
2051504	0	0	Wheeler	153	5	32	7.844	82	47.11
3051504	0	0	Wheeler	153	5	32	11.35	82	38.66
4051504	0	0	Wheeler	153	5	32	11.48	82	37.55
14122904	0	0	Wheeler	153	5	32	15.96	82	46.07
14092703	0	0	White	154	1	34	40.73	83	40.06
9080703	0	0	Whitfield	155	6	34	39.20	84	59.07
39051604	0	0	Wilcox	156	4	31	51.41	83	19.42
40051604	0	0	Wilcox	156	4	31	56.72	83	33.29
41051604	0	0	Wilcox	156	4	31	57.37	83	84.83
12060504	0	0	Wilkes	157	2	33	40.74	82	49.89
13060504	0	0	Wilkes	157	2	33	41.89	82	47.53
14060504	0	0	Wilkes	157	2	33	47.86	82	56.91
38031404	0	0	Wilkinson	158	2	32	46.90	82	57.61
33040304	0	0	Worth	159	4	31	30.73	83	46.59
35040304	0	0	Worth	159	4	31	39.95	83	52.37

APPENDIX B. Number of Roost and Non-Roost Bridges in Each Surveyed Georgia County

County	Roost	Non-Roost	Total
Appling		1	1
Atkinson		1	1
Bacon		2	2
Baldwin		4	4
Banks	2	2	4
Barrow		1	1
Bartow		7	7
Ben Hill		1	1
Berrien	1		1
Bibb		2	2
Bleckley		2	2
Brantley		6	6
Bryan		1	1
Bulloch	2	4	6
Burke	1	8	9
Butts		3	3
Camden		1	1
Candler	2	2	4
Carroll		2	2
Catoosa		4	4
Charlton		10	10
Chatham		6	6
Chattahoochee	2	1	3
Chattooga	1	3	4

County	Roost	Non-Roost	Total
Cherokee		3	3
Clarke		4	4
Clinch		13	13
Coffee		5	5
Colquitt		5	5
Columbia		4	4
Cook		1	1
Coweta		1	1
Crisp	1	3	4
Dade		2	2
Decatur	1	6	7
DeKalb		1	1
Dodge		2	2
Dooly		2	2
Dougherty	4		4
Douglas		1	1
Echols		3	3
Effingham		7	7
Elbert		6	6
Emanuel	2	11	13
Evans		1	1
Fannin	2		2
Floyd		5	5
Franklin		3	3

County	Roost	Non-Roost	Total
Gilmer		5	5
Glascock		3	3
Glynn		6	6
Gordon		8	8
Grady		8	8
Greene	2	3	5
Gwinnett		1	1
Habersham		1	1
Hancock		4	4
Haralson		6	6
Harris		6	6
Hart		2	2
Heard		3	3
Houston		5	5
Irwin		2	2
Jackson		2	2
Jasper		3	3
Jeff Davis		3	3
Jefferson		6	6
Jenkins		3	3
Johnson		3	3
Jones		2	2
Lamar	4	4	8
Lanier		3	3
Laurens		4	4

County	Roost	Non-Roost	Total
Lee		3	3
Liberty		8	8
Lincoln		1	1
Long		4	4
Macon		4	4
Madison		2	2
Marion		1	1
McDuffie		2	2
McIntosh		9	9
Meriwether		5	5
Mitchell	2	4	6
Monroe		5	5
Montgomery		1	1
Morgan		2	2
Murray		3	3
Muscogee	2	8	10
Newton		3	3
Oconee		2	2
Oglethorpe		3	3
Paulding		5	5
Peach		2	2
Pickens	1	2	3
Pike		2	2
Polk		3	3
Pulaski		2	2

County	Roost	Non-Roost	Total
Putnam		3	3
Quitman		3	3
Rabun	1	7	8
Randolph		2	2
Richmond		10	10
Schley	1	1	2
Screven		4	4
Seminole		3	3
Spalding		2	2
Stewart	2	10	12
Sumter	3	2	5
Talbot		6	6
Taliaferro		2	2
Tattnall		4	4
Taylor	3	5	8
Telfair		5	5
Terrell		3	3
Tift	4	1	5
Toombs		4	4

County	Roost	Non-Roost	Total
Towns	2	2	4
Treutlen		2	2
Troup		5	5
Twiggs		3	3
Union	3	4	7
Upson		6	6
Walker		6	6
Walton		1	1
Ware		4	4
Warren		3	3
Washington		3	3
Wayne		5	5
Webster	1	4	5
Wheeler		4	4
White		1	1
Whitfield		1	1
Wilcox		3	3
Wilkes		3	3
Wilkinson		1	1
Worth	3	2	5

APPENDIX C. Evidence of Bats at Roost Bridges

Evidence for Presence of Bats at Roost Bridges
(1 = Feature Observed on Bridge)

Bridge ID	Bats Observed	Staining Present	Guano Present	Odor Present	Vocalizations Present
2092703		1	1		
3092703		1	1		
6042305		1	1		
6110703		1			
7042305		1	1		
7110703		1			
8042305		1	1		
8101803		1			
8110703	1	1	1	1	1
9110703		1	1		
10092703			1		
11080803	1	1	1		1
12031304		1			
13031304		1	1		
14031304		1	1		
15031304		1	1		
15061204		1	1		
15092803	1		1		
16061204		1	1		
18031304		1	1		
19031304		1	1		
20050104	1				
20092803		1	1		
21092803		1	1		
21102003		1	1		
22040204		1	1		
22060504		1			
22092803		1	1		

Evidence for Presence of Bats at Roost Bridges
(1 = Feature Observed on Bridge)

Bridge ID	Bats Observed	Staining Present	Guano Present	Odor Present	Vocalizations Present
22102003		1	1		
23092803		1	1		
24060504		1		1	
25102003		1	1		
26102003		1	1		
27040304		1	1		
27102003	1	1	1		
28040304		1	1		
28102003		1	1		
29031304	1		1		1
29040304		1	1		
30040304		1	1		
31040304		1	1		
32012504			1		
32040304		1	1		
34040304		1	1		
37060604	1	1	1	1	1
38060604	1	1	1	1	1
39012504			1		
39060604		1	1	1	1
40012504			1		
40040304	1				
40060604		1	1	1	1
80010105		1	1		
81010105		1	1	1	1
83010105		1	1	1	
85010105	1	1	1		

Summary of Evidence for Presence of Bats at Roost Bridges

Type of Evidence	Frequency	% of Total Frequency of Evidence (N=120)	% of Total # Roost Bridges (N=55)
Bats Observed	10	8.33	18.18
Staining Present	47	39.17	85.45
Guano Present	47	39.17	85.45
Odor Present	8	6.67	14.55
Vocalizations Present	8	6.67	14.55
Total	120	100	

APPENDIX D. Location of Roost Sites on Roost Bridges

Locations of Roosts on Roost Bridges

Roost Bridge ID	Roost Location					
	Parallel Beams	Parallel Crevices	Transverse Crevices	Transverse Beams	Downspouts	Combination
11080803						3
22092803						4
23092803						4
21102003						1
22102003						1
27102003						2
08110703						6
09110703						2
20050104						1
24060504						1
81010105						4
83010105						6
29031304					16	
02092703	4					
03092703	4					
10092703	1					
20092803	2					
21092803	2					
28102003	2					
22060504	8					
40040304		1				
32012504				1		

Locations of Roosts on Roost Bridges

Roost Bridge ID	Roost Location					
	Parallel Beams	Parallel Crevices	Transverse Crevices	Transverse Beams	Downspouts	Combination
15092803			2			
08101803			2			
25102003			2			
26102003			2			
06110703			2			
07110703			2			
39012504			1			
40012504			1			
12031304			4			
13031304			3			
14031304			10			
15031304			10			
18031304			4			
19031304			7			
22040204			4			
27040304			5			
28040304			5			
29040304			1			
30040304			4			
31040304			2			
32040304			4			
34040304			2			
37060604			2			

Locations of Roosts on Roost Bridges

Roost Bridge ID	Roost Location					
	Parallel Beams	Parallel Crevices	Transverse Crevices	Transverse Beams	Downspouts	Combination
38060604			2			
39060604			2			
40060604			2			
15061204			5			
16061204			4			
80010105			5			
85010105			2			
06042305			2			
07042305			1			
08042305			10			

Summary of Roost Locations on Roost Bridges

Roost Location	Parallel Beams	Parallel Crevices	Transverse Crevices	Transverse Beams	Downspouts	[1] Combination	Total
# Roosts	23	1	116	1	16	35	192
% of Total	11.98%	0.52%	60.42%	0.52%	8.33%	18.23%	100.00 %

1. Combination of roost locations

APPENDIX E. Roost and Non-Roost Bridges Spanning Water or in Close Proximity to Water and Distances to such Water Sources

Water Conditions Beneath Roost and Non-Roost Bridges (Col. %)

	Roost Bridges		Non-Roost Bridges	
Water Condition	# Bridges	Column Valid N %	# Bridges	Column Valid N%
Flowing	31	67.4%	315	83.1%
Standing	13	28.3%	51	13.5%
Flowing and Standing	2	4.3%	13	3.4%
Column Totals	46	100.0%	379	100.0%

Water Conditions Beneath Roost and Non-Roost Bridges (Row %)

Water Condition	Bridge Type	# Bridges	Row Valid N%
Flowing Water (Total Valid Row N = 346)	Roost Bridges	31	9.0%
	Non-Roost Bridges	315	91.0%
Standing Water (Total Valid Row N = 64)	Roost Bridges	13	20.3%
	Non-Roost Bridges	51	79.7%
Standing and Flowing Water (Total Valid Row N = 15)	Roost Bridges	2	13.3%
	Non-Roost Bridges	13	86.7%

Flowing Water * Evidence of Bats Roosting Crosstabulation

			Non-Roost Bridges	Roost Bridges	Total
Flowing Water	No	Count	157	22	179
		% within Flowing Water	87.7%	12.3%	100.0%
	Yes	Count	328	33	361
		% within Flowing Water	90.9%	9.1%	100.0%
Total		Count	485	55	540
		% within Flowing Water	89.8%	10.2%	100.0%

Standing Water * Evidence of Bats Roosting Crosstabulation

			Non-Roost Bridges	Roost Bridges	Total
Standing Water	No	Count	421	40	461
		% within Standing Water	91.3%	8.7%	100.0%
	Yes	Count	64	15	79
		% within Standing Water	81.0%	19.0%	100.0%
Total		Count	485	55	540
		% within Standing Water	89.8%	10.2%	100.0%

Flowing and Standing Water * Evidence of Bats Roosting Crosstabulation

			Non-Roost Bridges	Roost Bridges	Total
Flowing and Standing Water	No	Count	106	9	115
		% within Flowing and Standing Water	92.2%	7.8%	100.0%
	Yes	Count	379	46	425
		% within Flowing and Standing Water	89.2%	10.8%	100.0%
Total		Count	485	55	540
		% within Flowing and Standing Water	89.8%	10.2%	100.0%

Distance to Water (Kilometers)

	Roost Bridges	Non-Roost Bridges
Mean	.06	.23
Std. Dev.	.18	.64
Minimum	0	0
Maximum	1	5
Valid N	55	482

Distance to Water (Miles)

	Roost Bridges	Non-Roost Bridges
Mean	.03	.13
Std. Dev.	.10	.35
Minimum	0	0
Maximum	1	3
Valid N	55	482

Distance to Water(Miles)from Bridges with No Flowing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.09	.40
Std. Dev.	.14	.53
Maximum	1	3
Valid N	22	154

Distance to Water (Miles) from Bridges with No Standing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.05	.15
Standard Deviation	.11	.38
Maximum	1	3
Valid N	40	418

Distance to Water (Miles) from Bridges with No Flowing or Standing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.21	.59
Standard Deviation	.15	.55
Maximum	1	3
Valid N	9	103

Distance to Water (Kilometers) from Bridges with No Flowing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.15	.72
Standard Deviation	.25	.95
Maximum	1	5
Valid N	22	154

Distance to Water (Kilometers) from Bridges with No Standing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.08	.27
Standard Deviation	.20	.68
Maximum	1	5
Valid N	40	418

Distance to Water (Kilometers) from Bridges with No Flowing or Standing Water Beneath

	Roost Bridges	Non-Roost Bridges
Mean	.37	1.07
Standard Deviation	.27	.99
Maximum	1	5
Valid N	9	103

APPENDIX F. Elevational Data for Roost and Non-Roost Bridges

Roost Bridge Elevations (Meters)

Bridge ID	Elevation	Bridge ID	Elevation
12031304	49.31	29031304	95.17
28040304	126.90	38060604	294.83
13031304	62.41	21102003	95.52
34040304	137.93	39060604	294.83
8101803	63.10	22102003	95.52
28102003	139.66	40060604	294.83
14031304	63.79	18031304	103.10
27102003	139.66	6042305	327.24
15031304	63.79	30040304	106.55
83010105	153.45	11080803	374.14
32012504	64.48	29040304	106.55
6110703	158.62	10092703	561.03
8110703	73.10	22040204	114.48
7110703	158.62	22092803	563.45
39012504	78.62	81010105	118.97
22060504	168.62	23092803	563.45
40012504	78.62	85010105	118.97
7042305	169.31	20092803	643.45
19031304	90.69	31040304	120.34
24060504	196.55	21092803	643.45
25102003	91.72	32040304	120.34
16061204	244.48	15092803	657.59
26102003	91.72	80010105	120.34
20050104	259.66	3092703	672.76
40040304	93.10	8042305	124.48
15061204	275.86	2092703	672.76
9110703	93.45	27040304	126.90
37060604	294.83		

Non-Roost Bridge Elevations (Meters)

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
56123104	1.03	27012504	37.24	5051504	60.34
45123104	2.07	17051504	38.28	10031304	60.69
61123104	2.41	26123004	39.31	27031304	60.69
46123104	3.10	23012404	39.31	28031304	60.69
47123104	3.10	2101703	39.66	11031304	60.69
59123104	6.90	3051504	39.66	16122904	60.69
55123104	7.59	26012404	39.66	7012404	61.03
54123104	8.62	27123004	40.00	12101803	61.38
39123004	8.97	18012404	40.00	13101803	61.38
65123104	9.31	19012404	40.00	6051504	61.38
66123104	10.69	1101703	41.03	25051504	61.72
48123104	11.38	11051504	41.72	20012404	61.72
43123104	11.72	12051504	41.72	31012504	62.76
38123004	12.76	14122904	42.07	9101803	63.10
31123004	12.76	22012404	42.07	10101803	63.79
30123004	12.76	18051504	42.41	6031204	63.79
57123104	13.79	15122904	43.10	18102003	64.83
52123104	13.79	28012504	43.79	23102003	64.83
58123104	13.79	4101803	44.83	24102003	64.83
53123104	13.79	19051504	46.21	28051504	65.17
49123104	14.48	6012404	46.55	29051504	65.17
50123104	14.48	21122904	46.90	30012504	65.52
51123104	14.48	17102003	47.59	21051504	66.21
63123104	15.17	26051504	49.66	12122904	66.21
64123104	15.17	27051504	49.66	17122904	66.55
62123104	15.52	5101803	49.66	4051504	66.55
44123104	15.52	8031304	50.00	22051504	67.24
32123004	17.93	10051504	51.03	4122804	67.24
33123004	17.93	20051504	51.38	67123104	67.93
25012404	20.00	17031304	53.79	68123104	67.93
41123004	20.69	7051504	54.14	18122904	67.93
42123004	20.69	20122904	54.48	11101803	68.62
29123004	21.38	21012404	54.83	30051604	69.31
28123004	21.38	9031304	55.17	12012404	70.34
34123004	21.72	29012504	55.52	14012404	70.69
35123004	21.72	16031304	55.86	4012304	70.69
60123104	22.76	22122904	55.86	6101803	71.03
36123004	25.52	23122904	55.86	7101803	71.03
37123004	25.52	2012304	56.21	19122904	71.72
40123004	26.21	75010105	56.55	9051504	72.41
24012404	26.21	76010105	56.55	13012404	72.41
69123104	31.03	73123104	57.24	15012404	72.41
70123104	31.03	74123104	57.24	36042405	72.76
13051504	34.48	58042505	57.24	3031204	74.14
14051504	34.48	3101803	58.62	35042405	75.17
72123104	34.48	8012404	58.97	19102003	75.17
71123104	34.48	32051604	59.31	22031304	75.86
16051504	35.86	31051604	59.31	15101803	75.86
15051504	35.86	7031304	59.66	14101803	75.86
17012404	36.90	31031404	60.00	16101903	76.21
16012404	36.90	3012304	60.00	5012304	76.21

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
30031304	77.59	6032604	99.66	41051604	137.24
41042505	78.62	57042505	100.69	33040304	137.93
42042505	78.62	11032604	100.69	35040304	138.97
13122904	78.62	4032604	102.76	15040204	138.97
23051504	79.31	35031404	103.45	16040204	138.97
20102003	79.31	36051604	104.48	3110703	139.31
4031204	79.31	13040204	105.86	1110703	140.00
11012404	79.31	77010105	105.86	2110703	140.00
8032604	80.00	5032604	106.55	6122904	142.41
5031204	80.00	10032604	108.97	3040204	143.10
26031304	80.00	52042505	109.66	4040204	143.10
37031404	80.34	36031404	110.00	7122904	144.48
10012404	81.03	11040204	112.41	11060504	144.83
1031204	81.38	59042505	112.41	21042405	146.90
2031204	81.38	38051604	113.10	54042505	147.24
37042405	82.07	49042505	113.10	14032604	147.59
10110703	84.14	48042505	113.10	13032604	147.59
11110703	84.14	84010105	113.79	37051604	148.62
38031404	84.48	12040204	114.14	26042405	148.97
35012404	84.83	21040204	114.14	13060504	149.31
24031304	84.83	38012504	114.83	86010105	150.69
25031304	84.83	46042505	115.86	87010105	150.69
9012404	85.86	47042505	115.86	12060504	150.69
33051604	85.86	7040204	115.86	61042505	153.45
8051504	86.21	8040204	116.21	82010105	153.45
2051504	86.21	34042405	117.59	62042505	153.45
34012504	86.21	9040204	118.28	4061204	155.86
33012504	88.28	10040204	118.28	29042405	157.24
2032604	88.62	78010105	118.97	8122904	157.59
3032604	88.62	55042505	119.66	20042405	158.28
1032604	88.97	26040304	120.34	5042305	160.00
11122904	90.00	10122904	120.69	1042305	161.38
34051604	90.00	24040204	120.69	2042305	161.38
35051604	91.03	25040204	120.69	30042405	161.38
23031304	91.03	9122904	122.41	22042405	164.14
20031304	91.38	32042405	122.76	9060504	164.48
32031404	91.38	56042505	123.45	3061204	166.90
24051504	91.38	12032604	126.21	43042505	168.28
38040304	92.76	79010105	127.59	25060504	168.62
36012504	92.76	23040204	128.28	9042305	170.34
37012504	92.76	36040304	128.97	10060504	170.34
21031304	93.10	40051604	129.31	21060504	170.69
39040304	93.10	44042505	129.31	1122804	173.79
39031404	93.10	45042505	129.31	19042405	175.17
40031404	93.10	3042305	130.00	14060504	176.21
7032604	95.17	4042305	130.00	17040204	177.24
38042405	95.52	50042505	132.07	18040204	177.93
39042405	95.52	51042505	132.07	2122804	178.97
40042405	95.52	53042505	132.41	25042405	180.34
34031404	96.55	14040204	134.14	24042405	180.34
9032604	96.90	33042405	134.14	23042405	180.69
1012304	97.24	5122804	136.21	18042405	183.45
39051604	97.24	1040204	136.55	5061204	183.45
37040304	97.93	2040204	136.55	17042405	184.14
33031404	99.31	28042405	136.55	19040204	184.48

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
20040204	184.83	29050104	241.72	15040504	292.41
26060504	185.52	36050104	242.07	3060404	294.48
15060504	185.52	16043004	244.14	9080703	296.55
7061204	186.55	17043004	244.14	13061204	302.76
31042405	188.28	17080803	244.14	16040504	303.45
11042305	188.62	7060404	244.48	3080703	305.17
10042305	190.34	17061204	244.48	4080703	305.17
4110703	190.69	9061204	246.55	2060404	305.86
2061204	193.45	34050104	246.90	5080703	308.28
41040304	194.48	28060604	247.93	6080703	308.28
27060604	196.21	14042305	248.97	19040504	310.34
16060504	196.55	14080803	249.31	43050204	314.48
27042405	199.66	18061204	250.34	42050204	314.48
41060604	200.34	8060504	251.03	41050204	315.86
4040504	200.69	21050104	252.76	44050204	317.59
5040504	200.69	6060404	254.83	12061204	320.34
2040504	200.69	19061204	257.24	4043004	335.86
3040504	200.69	13080803	257.93	32092803	342.07
1040504	200.69	6061204	260.00	31060604	344.14
6040504	200.69	8080703	260.34	32060604	344.14
7040504	200.69	29060604	260.69	5043004	344.83
1061204	204.83	14061204	262.41	4060404	355.17
5110703	205.17	22050104	264.14	10043004	357.59
17060504	206.55	7080703	264.48	11043004	357.59
23060504	206.55	2080703	265.52	30050104	361.03
8040504	215.17	37050104	266.55	12080803	364.14
8061204	217.24	38050204	267.93	9043004	366.90
12042305	217.93	39050204	267.93	8043004	373.10
13042305	217.93	24050104	268.28	6043004	396.21
11040504	217.93	25050104	268.28	7043004	396.21
16042305	218.28	23050104	268.28	30092803	403.10
20060504	222.76	20061204	270.34	31092803	403.10
14043004	223.10	21061204	270.34	28092803	413.79
15043004	223.10	10061204	271.38	29092803	413.79
33060604	223.79	16080803	272.41	27092803	468.97
34060604	223.79	32050104	275.17	13092703	481.38
9040504	223.79	33050104	275.17	14092703	485.17
10040504	223.79	31050104	276.21	10080703	511.72
18060504	224.83	30060604	276.21	12092703	540.34
19060504	224.83	13043004	276.55	8092703	559.66
1060404	226.90	15080803	277.24	26092803	561.03
3043004	227.24	26050104	277.24	24092803	562.07
2043004	228.28	18040504	279.31	25092803	562.07
19050104	232.41	17040504	279.31	11092703	568.28
18080803	232.76	40050204	280.00	9092703	568.28
1043004	233.45	11061204	282.07	18092803	622.76
18050104	234.83	27050104	282.41	19092803	622.76
35050104	235.17	12043004	283.79	16092803	638.62
19080803	236.21	5060404	285.52	7092703	653.45
5040204	241.03	14040504	286.90	17092803	663.10
6040204	241.03	35060604	288.97	4092703	677.93
28050104	241.72	36060604	288.97	5092703	677.93
				1092703	682.07

Roost Bridge Elevations (Feet)

Bridge ID	Elevation	Bridge ID	Elevation
12031304	143.00	37060604	855.00
28040304	368.00	29031304	276.00
13031304	181.00	38060604	855.00
34040304	400.00	21102003	277.00
8101803	183.00	39060604	855.00
28102003	405.00	22102003	277.00
14031304	185.00	40060604	855.00
27102003	405.00	18031304	299.00
15031304	185.00	6042305	949.00
83010105	445.00	30040304	309.00
32012504	187.00	11080803	1085.00
6110703	460.00	29040304	309.00
8110703	212.00	10092703	1627.00
7110703	460.00	22040204	332.00
39012504	228.00	22092803	1634.00
22060504	489.00	81010105	345.00
40012504	228.00	23092803	1634.00
7042305	491.00	85010105	345.00
19031304	263.00	20092803	1866.00
24060504	570.00	31040304	349.00
25102003	266.00	21092803	1866.00
16061204	709.00	32040304	349.00
26102003	266.00	15092803	1907.00
20050104	753.00	80010105	349.00
40040304	270.00	3092703	1951.00
15061204	800.00	8042305	361.00
9110703	271.00	2092703	1951.00
		27040304	368.00

Non-Roost Elevations (Feet)

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
56123104	3.00	17051504	111.00	7031304	176.00
45123104	6.00	26123004	114.00	28031304	176.00
61123104	7.00	23012404	114.00	11031304	176.00
46123104	9.00	2101703	115.00	16122904	176.00
47123104	9.00	3051504	115.00	7012404	177.00
59123104	20.00	26012404	115.00	12101803	178.00
55123104	22.00	27123004	116.00	13101803	178.00
54123104	25.00	18012404	116.00	6051504	178.00
39123004	26.00	19012404	116.00	25051504	179.00
65123104	27.00	1101703	119.00	20012404	179.00
66123104	31.00	11051504	121.00	31012504	182.00
48123104	33.00	12051504	121.00	9101803	183.00
43123104	34.00	14122904	122.00	10101803	185.00
38123004	37.00	22012404	122.00	6031204	185.00
31123004	37.00	18051504	123.00	18102003	188.00
30123004	37.00	15122904	125.00	23102003	188.00
57123104	40.00	28012504	127.00	24102003	188.00
52123104	40.00	4101803	130.00	28051504	189.00
58123104	40.00	19051504	134.00	29051504	189.00
53123104	40.00	6012404	135.00	30012504	190.00
49123104	42.00	21122904	136.00	21051504	192.00
50123104	42.00	17102003	138.00	12122904	192.00
51123104	42.00	26051504	144.00	17122904	193.00
63123104	44.00	27051504	144.00	4051504	193.00
64123104	44.00	5101803	144.00	22051504	195.00
62123104	45.00	8031304	145.00	4122804	195.00
44123104	45.00	10051504	148.00	67123104	197.00
32123004	52.00	20051504	149.00	68123104	197.00
33123004	52.00	17031304	156.00	18122904	197.00
25012404	58.00	7051504	157.00	11101803	199.00
41123004	60.00	20122904	158.00	30051604	201.00
42123004	60.00	21012404	159.00	12012404	204.00
29123004	62.00	9031304	160.00	14012404	205.00
28123004	62.00	29012504	161.00	4012304	205.00
34123004	63.00	16031304	162.00	6101803	206.00
35123004	63.00	22122904	162.00	7101803	206.00
60123104	66.00	23122904	162.00	19122904	208.00
36123004	74.00	2012304	163.00	9051504	210.00
37123004	74.00	75010105	164.00	13012404	210.00
40123004	76.00	76010105	164.00	15012404	210.00
24012404	76.00	73123104	166.00	36042405	211.00
69123104	90.00	74123104	166.00	3031204	215.00
70123104	90.00	58042505	166.00	35042405	218.00
13051504	100.00	3101803	170.00	19102003	218.00
14051504	100.00	8012404	171.00	22031304	220.00
72123104	100.00	32051604	172.00	15101803	220.00
71123104	100.00	31051604	172.00	14101803	220.00
16051504	104.00	7031304	173.00	16101903	221.00
15051504	104.00	31031404	174.00	5012304	221.00
17012404	107.00	3012304	174.00	30031304	225.00
16012404	107.00	5051504	175.00	41042505	228.00
27012504	108.00	10031304	176.00	42042505	228.00

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
13122904	228.00	57042505	292.00	28042405	396.00
23051504	230.00	11032604	292.00	41051604	398.00
20102003	230.00	4032604	298.00	33040304	400.00
4031204	230.00	35031404	300.00	35040304	403.00
11012404	230.00	36051604	303.00	15040204	403.00
8032604	232.00	13040204	307.00	16040204	403.00
5031204	232.00	77010105	307.00	3110703	404.00
26031304	232.00	5032604	309.00	1110703	406.00
37031404	233.00	10032604	316.00	2110703	406.00
10012404	235.00	52042505	318.00	6122904	413.00
1031204	236.00	36031404	319.00	3040204	415.00
2031204	236.00	11040204	326.00	4040204	415.00
37042405	238.00	59042505	326.00	7122904	419.00
10110703	244.00	38051604	328.00	11060504	420.00
11110703	244.00	49042505	328.00	21042405	426.00
38031404	245.00	48042505	328.00	54042505	427.00
35012404	246.00	84010105	330.00	14032604	428.00
24031304	246.00	12040204	331.00	13032604	428.00
25031304	246.00	21040204	331.00	37051604	431.00
9012404	249.00	38012504	333.00	26042405	432.00
33051604	249.00	46042505	336.00	13060504	433.00
8051504	250.00	47042505	336.00	86010105	437.00
2051504	250.00	7040204	336.00	87010105	437.00
34012504	250.00	8040204	337.00	12060504	437.00
33012504	256.00	34042405	341.00	61042505	445.00
2032604	257.00	9040204	343.00	82010105	445.00
3032604	257.00	10040204	343.00	62042505	445.00
1032604	258.00	78010105	345.00	4061204	452.00
11122904	261.00	55042505	347.00	29042405	456.00
34051604	261.00	26040304	349.00	8122904	457.00
35051604	264.00	10122904	350.00	20042405	459.00
23031304	264.00	24040204	350.00	5042305	464.00
20031304	265.00	25040204	350.00	1042305	468.00
32031404	265.00	9122904	355.00	2042305	468.00
24051504	265.00	32042405	356.00	30042405	468.00
38040304	269.00	56042505	358.00	22042405	476.00
36012504	269.00	12032604	366.00	9060504	477.00
37012504	269.00	79010105	370.00	3061204	484.00
21031304	270.00	23040204	372.00	43042505	488.00
39040304	270.00	36040304	374.00	25060504	489.00
39031404	270.00	40051604	375.00	9042305	494.00
40031404	270.00	44042505	375.00	10060504	494.00
7032604	276.00	45042505	375.00	21060504	495.00
38042405	277.00	3042305	377.00	1122804	504.00
39042405	277.00	4042305	377.00	19042405	508.00
40042405	277.00	50042505	383.00	14060504	511.00
34031404	280.00	51042505	383.00	17040204	514.00
9032604	281.00	53042505	384.00	18040204	516.00
1012304	282.00	14040204	389.00	2122804	519.00
39051604	282.00	33042405	389.00	25042405	523.00
37040304	284.00	5122804	395.00	24042405	523.00
33031404	288.00	1040204	396.00	23042405	524.00
6032604	289.00	2040204	396.00	18042405	532.00

Bridge ID	Elevation	Bridge ID	Elevation	Bridge ID	Elevation
5061204	532.00	28050104	701.00	3060404	854.00
17042405	534.00	29050104	701.00	9080703	860.00
19040204	535.00	36050104	702.00	13061204	878.00
20040204	536.00	16043004	708.00	16040504	880.00
26060504	538.00	17043004	708.00	3080703	885.00
15060504	538.00	17080803	708.00	4080703	885.00
7061204	541.00	7060404	709.00	2060404	887.00
31042405	546.00	17061204	709.00	5080703	894.00
11042305	547.00	9061204	715.00	6080703	894.00
10042305	552.00	34050104	716.00	19040504	900.00
4110703	553.00	28060604	719.00	43050204	912.00
2061204	561.00	14042305	722.00	42050204	912.00
41040304	564.00	14080803	723.00	41050204	916.00
27060604	569.00	18061204	726.00	44050204	921.00
16060504	570.00	8060504	728.00	12061204	929.00
27042405	579.00	21050104	733.00	4043004	974.00
41060604	581.00	6060404	739.00	32092803	992.00
4040504	582.00	19061204	746.00	31060604	998.00
5040504	582.00	13080803	748.00	32060604	998.00
2040504	582.00	6061204	754.00	5043004	1000.00
3040504	582.00	8080703	755.00	4060404	1030.00
1040504	582.00	29060604	756.00	10043004	1037.00
6040504	582.00	14061204	761.00	11043004	1037.00
7040504	582.00	22050104	766.00	30050104	1047.00
1061204	594.00	7080703	767.00	12080803	1056.00
5110703	595.00	2080703	770.00	9043004	1064.00
17060504	599.00	37050104	773.00	8043004	1082.00
23060504	599.00	38050204	777.00	6043004	1149.00
8040504	624.00	39050204	777.00	7043004	1149.00
8061204	630.00	24050104	778.00	30092803	1169.00
12042305	632.00	25050104	778.00	31092803	1169.00
13042305	632.00	23050104	778.00	28092803	1200.00
11040504	632.00	20061204	784.00	29092803	1200.00
16042305	633.00	21061204	784.00	27092803	1360.00
20060504	646.00	10061204	787.00	13092703	1396.00
14043004	647.00	16080803	790.00	14092703	1407.00
15043004	647.00	32050104	798.00	10080703	1484.00
33060604	649.00	33050104	798.00	12092703	1567.00
34060604	649.00	31050104	801.00	8092703	1623.00
9040504	649.00	30060604	801.00	26092803	1627.00
10040504	649.00	13043004	802.00	24092803	1630.00
18060504	652.00	15080803	804.00	25092803	1630.00
19060504	652.00	26050104	804.00	11092703	1648.00
1060404	658.00	18040504	810.00	9092703	1648.00
3043004	659.00	17040504	810.00	18092803	1806.00
2043004	662.00	40050204	812.00	19092803	1806.00
19050104	674.00	11061204	818.00	16092803	1852.00
18080803	675.00	27050104	819.00	7092703	1895.00
1043004	677.00	12043004	823.00	17092803	1923.00
18050104	681.00	5060404	828.00	4092703	1966.00
35050104	682.00	14040504	832.00	5092703	1966.00
19080803	685.00	35060604	838.00	1092703	1978.00
5040204	699.00	36060604	838.00		
6040204	699.00	15040504	848.00		

APPENDIX G. Age of Roost and Non-Roost Bridges

Roost Bridges Construction Date and Age (Years)

Bridge ID	Date	Age	Bridge ID	Date	Age
8101803	1996	9	13031304	1974	31
3092703	1990	15	12031304	1972	33
22060504	1990	15	9110703	1969	36
2092703	1989	16	24060504	1969	36
83010105	1988	17	37060604	1964	41
20092803	1986	19	38060604	1964	41
21092803	1986	19	39060604	1964	41
20050104	1986	19	40060604	1964	41
27102003	1984	21	22102003	1961	44
30040304	1983	22	29031304	1960	45
31040304	1983	22	10092703	1959	46
29040304	1982	23	25102003	1959	46
32040304	1982	23	26102003	1959	46
22092803	1981	24	39012504	1959	46
23092803	1981	24	18031304	1959	46
15092803	1980	25	80010105	1959	46
21102003	1980	25	6042305	1959	46
27040304	1979	26	40012504	1958	47
28040304	1979	26	19031304	1958	47
15061204	1979	26	85010105	1958	47
16061204	1979	26	8110703	1957	48
40040304	1978	27	7042305	1955	50
81010105	1978	27	8042305	1955	50
11080803	1977	28	34040304	1953	52
14031304	1977	28	22040204	1951	54
15031304	1977	28	32012504	1949	56

Non-Roost Bridges Construction Date and Age (Years)

Bridge ID	Date	Age
37050104	2004	1
32051604	2004	1
7060404	2003	2
41042505	2003	2
42042505	2003	2
14043004	2002	3
15043004	2002	3
34050104	2002	3
40051604	2002	3
10061204	2002	3
49042505	2002	3
50042505	2002	3
12101803	2001	4
13101803	2001	4
10043004	2001	4
11043004	2001	4
27123004	2001	4
43042505	2001	4
48042505	2001	4
51042505	2001	4
10080703	2000	5
10110703	2000	5
11110703	2000	5
1012304	2000	5
2032604	2000	5
3032604	2000	5
9032604	2000	5
14032604	2000	5
3040204	2000	5
4040204	2000	5
5060404	2000	5
3042305	2000	5
1040204	1999	6
2040204	1999	6
8051504	1999	6
9051504	1999	6
28051504	1999	6
29051504	1999	6
20060504	1999	6
57123104	1999	6
1042305	1999	6
2042305	1999	6
4042305	1999	6
31042405	1999	6
10101803	1998	7
11101803	1998	7
5040204	1998	7
6040204	1998	7
9040204	1998	7
12043004	1998	7
43050204	1998	7
21051504	1998	7
34123004	1998	7

Bridge ID	Date	Age
35123004	1998	7
15042305	1998	7
9012404	1997	8
10012404	1997	8
22050104	1997	8
20061204	1997	8
21061204	1997	8
36123004	1997	8
37123004	1997	8
16101903	1996	9
21012404	1996	9
15040204	1996	9
16040204	1996	9
18040204	1996	9
19040204	1996	9
26060504	1996	9
17061204	1996	9
19122904	1996	9
32123004	1996	9
33123004	1996	9
41123004	1996	9
63123104	1996	9
64123104	1996	9
12042305	1996	9
13042305	1996	9
21042405	1996	9
6101803	1995	10
7101803	1995	10
22031304	1995	10
8032604	1995	10
2051504	1995	10
2122804	1995	10
9101803	1994	11
17012404	1994	11
34012504	1994	11
35012404	1994	11
20031304	1994	11
21031304	1994	11
36031404	1994	11
13040204	1994	11
22051504	1994	11
17042405	1994	11
53042505	1994	11
12092703	1993	12
36012504	1993	12
37012504	1993	12
1031204	1993	12
2031204	1993	12
7031304	1993	12
32031404	1993	12
37031404	1993	12
10032604	1993	12
12032604	1993	12

Bridge ID	Date	Age
13032604	1993	12
11051504	1993	12
12051504	1993	12
13051504	1993	12
14051504	1993	12
5061204	1993	12
8061204	1993	12
77010105	1993	12
52042505	1993	12
17102003	1992	13
18102003	1992	13
16012404	1992	13
18012404	1992	13
19012404	1992	13
31031404	1992	13
18050104	1992	13
38050204	1992	13
39050204	1992	13
41050204	1992	13
42050204	1992	13
6051504	1992	13
36051604	1992	13
39051604	1992	13
11122904	1992	13
14122904	1992	13
38123004	1992	13
42123004	1992	13
28012504	1991	14
41060604	1991	14
12122904	1991	14
13122904	1991	14
2080703	1990	15
14092703	1990	15
15101803	1990	15
29012504	1990	15
30012504	1990	15
31012504	1990	15
3043004	1990	15
35050104	1990	15
23051504	1990	15
24051504	1990	15
13060504	1990	15
7061204	1990	15
86010105	1990	15
87010105	1990	15
44042505	1990	15
45042505	1990	15
46042505	1990	15
47042505	1990	15
26092803	1989	16
24012404	1989	16
26012404	1989	16
11040204	1989	16

Bridge ID	Date	Age
62123104	1989	16
9042305	1989	16
18080803	1988	17
13092703	1988	17
34031404	1988	17
35031404	1988	17
5032604	1988	17
7032604	1988	17
7080703	1987	18
3110703	1987	18
16031304	1987	18
6032604	1987	18
26040304	1987	18
4040504	1987	18
1051504	1987	18
26051504	1987	18
30051604	1987	18
43123104	1987	18
67123104	1987	18
68123104	1987	18
69123104	1987	18
70123104	1987	18
16080803	1986	19
18092803	1986	19
19092803	1986	19
4032604	1986	19
21050104	1986	19
24050104	1986	19
10051504	1986	19
27051504	1986	19
9060504	1986	19
25060504	1986	19
1061204	1986	19
72123104	1986	19
1122804	1985	20
3122804	1985	20
4122804	1985	20
12080803	1984	21
24040204	1984	21
25040204	1984	21
2043004	1984	21
3061204	1984	21
19050104	1983	22
73123104	1983	22
74123104	1983	22
27092803	1982	23
12040204	1982	23
13043004	1982	23
75010105	1982	23
33031404	1981	24
33040304	1981	24
59123104	1981	24
17092803	1980	25

Bridge ID	Date	Age
14101803	1980	25
23102003	1980	25
38012504	1980	25
29123004	1980	25
31123004	1980	25
5040504	1979	26
17122904	1979	26
18122904	1979	26
28123004	1979	26
30123004	1979	26
33051604	1978	27
61042505	1978	27
16092803	1977	28
11040504	1977	28
12040504	1977	28
13040504	1977	28
39040304	1976	29
6043004	1976	29
7043004	1976	29
24122904	1976	29
25122904	1976	29
7040204	1975	30
18060504	1975	30
19060504	1975	30
14080803	1974	31
15080803	1974	31
1043004	1974	31
25050104	1974	31
1101703	1973	32
8040204	1973	32
8012404	1972	33
10031304	1972	33
49123104	1972	33
50123104	1972	33
76010105	1972	33
4043004	1971	34
16051504	1971	34
5122804	1971	34
35042405	1971	34
36042405	1971	34
37042405	1971	34
59042505	1971	34
71123104	1970	35
19102003	1969	36
20102003	1969	36
44050204	1969	36
7122904	1969	36
28042405	1969	36
2040504	1968	37
3040504	1968	37
8122904	1968	37
16043004	1967	38
17043004	1967	38

Bridge ID	Date	Age
31060604	1967	38
32060604	1967	38
33060604	1967	38
34060604	1967	38
35060604	1967	38
36060604	1967	38
18061204	1967	38
54123104	1967	38
6061204	1966	39
14042305	1966	39
1080703	1965	40
6031204	1965	40
14040204	1965	40
6122904	1965	40
17031304	1964	41
1040504	1964	41
17040504	1964	41
14060504	1964	41
15060504	1964	41
16060504	1964	41
17060504	1964	41
38042405	1964	41
39042405	1964	41
40042405	1964	41
17040204	1963	42
9040504	1963	42
10040504	1963	42
19042405	1963	42
20042405	1963	42
9080703	1962	43
5101803	1962	43
4031204	1962	43
5031204	1962	43
27050104	1962	43
20051504	1962	43
9061204	1962	43
11061204	1962	43
12061204	1962	43
13061204	1962	43
26123004	1962	43
8080703	1961	44
1110703	1961	44
2110703	1961	44
4110703	1961	44
5110703	1961	44
41040304	1961	44
82010105	1961	44
24102003	1960	45
26031304	1960	45
27031304	1960	45
28031304	1960	45
57042505	1960	45
58042505	1960	45

Bridge ID	Date	Age	Bridge ID	Date	Age
9092703	1959	46	27012504	1955	50
32050104	1959	46	23040204	1955	50
33050104	1959	46	36040304	1955	50
8060504	1959	46	37040304	1955	50
27060604	1959	46	2060404	1955	50
5042305	1959	46	3060404	1955	50
25042405	1959	46	44123104	1955	50
13012404	1958	47	47123104	1955	50
14012404	1958	47	48123104	1955	50
15012404	1958	47	53123104	1955	50
30031304	1958	47	55123104	1955	50
6040504	1958	47	60123104	1955	50
7040504	1958	47	61123104	1955	50
10060504	1958	47	65123104	1955	50
11060504	1958	47	66123104	1955	50
15051504	1957	48	78010105	1955	50
19051504	1957	48	79010105	1955	50
4060404	1957	48	60042505	1955	50
45123104	1957	48	5043004	1954	51
46123104	1957	48	8043004	1954	51
62042505	1957	48	1060404	1954	51
12012404	1956	49	29060604	1954	51
4051504	1956	49	16042305	1954	51
5051504	1956	49	11012404	1953	52
25051504	1956	49	9043004	1953	52
14061204	1956	49	33042405	1953	52
39123004	1956	49	55042505	1953	52
51123104	1956	49	56042505	1953	52
52123104	1956	49	2012304	1952	53
58123104	1956	49	3012304	1952	53
17080803	1955	50	7012404	1952	53
4012304	1955	50	37051604	1952	53
5012304	1955	50	32042405	1952	53
22012404	1955	50	34042405	1952	53
23012404	1955	50	34051604	1951	54
25012404	1955	50	35051604	1951	54

Bridge ID	Date	Age	Bridge ID	Date	Age
12060504	1951	54	25031304	1946	59
3101803	1950	55	11032604	1946	59
6012404	1950	55	20122904	1945	60
8040504	1950	55	21122904	1945	60
15040504	1950	55	22122904	1945	60
19040504	1950	55	23122904	1945	60
6060404	1950	55	39031404	1944	61
20012404	1949	56	40031404	1944	61
33012504	1949	56	56123104	1944	61
30050104	1949	56	9031304	1943	62
31050104	1949	56	11031304	1941	64
24042405	1949	56	16040504	1941	64
3031204	1948	57	23050104	1941	64
20040204	1948	57	40050204	1940	65
21040204	1948	57	16122904	1940	65
23060504	1948	57	26042405	1940	65
84010105	1948	57	1092703	1939	66
27042405	1948	57	38031404	1939	66
8031304	1947	58	15122904	1939	66
36050104	1947	58	28060604	1938	67
21060504	1947	58	1032604	1937	68
30060604	1947	58	10040204	1937	68
22042405	1947	58	14040504	1937	68
23042405	1947	58	26050104	1937	68
23031304	1946	59	30042405	1937	68
24031304	1946	59	31051604	1935	70

APPENDIX H. Ecology and Status of Georgia Bat Species

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Corynorhinus rafinesquiiyes Rafinesque's Big-eared Bat (Jones, 1977)	Insectivorous	A pregnant female bears a single young anytime from late May through early June.	The time of hibernation for this species is not clear. In the northern part of its range, hibernating bats were found throughout the winter. In Louisiana, only 20% of these bats observed from December to May were in torpor. Roosting sites utilized most often by this species are partially lighted, mostly unoccupied buildings and other manmade structures.
Eptesicus fuscus Big Brown Bat (Kurta and Baker, 1990)	Small beetle species, including crop and forest pests, comprise most of the diet. Moths and leafhoppers are also common prey.	Maternity colonies form in the Spring, with one young being born to a female by May.	Summer colonies may begin to disperse as early as August; however, many of bats of this species do not arrive at hibernacula until November. Hibernacula are rarely located more than 80 km from summer roosts, and bats may enter and leave hibernacula during the winter months. This species has a well documented homing ability.
Lasionycteris noctivagans Silver-haired Bat (Kunz, 1982)	Flies, midges, leafhoppers, moths, mosquitoes, beetles, crane flies, lacewings, caddis flies, ants, crickets, occasional spiders.	Females bear one to two young (usually two) per litter anytime from May through June.	Little is known of summer roosting habits; no reliable reports of large winter or summer aggregations. Published observations of seasonal distributions indicate the species' range shifts north in Spring and south in Fall.

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Lasiurus borealis Eastern Red Bat (Shump and Shump, 1982)	Leafhoppers, beetles, moths, flies, true bugs, cicadas, and grounddwelling crickets.	Young are born in June. A pregnant female can bear one to five young in a litter.	Red bats are thought to be highly migratory. Wintering sites, though not well documented, are thought to be located in southern states due to the increased numbers of red bats in those states from December through March.
Lasiurus cinereus Hoary Bat (Shump and Shump, 1982)	Strong preference for moths; also preys upon beetles, flies, grasshoppers, termites, dragonflies, and wasps.	Parturition ranges from mid-May into early June. One to four young can be born to a female in a single litter, though the usual number is two.	Wintering sites are not well - documented and no specific migration routes have been identified; however, this species has been documented flying in large groups in the spring and in the fall, consistent with migration behavior.
Lasiurus intermedius Northern Yellow Bat (Webster, et.al., 1980)	Leafhoppers, flying ants, flies, beetles, mosquitoes, and occasionally dragonflies and damselflies.	A pregnant female bears two to four young per litter anytime from May through June.	These bats roost year round in Spanish moss or beneath the dead, hanging fronds of fan palms; species is nonmigratory. Bats remain active year round except for periods of extreme winter weather, during which they become torpid (BCI website).
Lasiurus seminolus Seminole Bat (Wilkins, 1987)	Mostly flies, beetles, true bugs, and even flightless crickets.	Young born in late May/June. Usually two young (sometimes as many as four) are born to a single pregnant female.	Migratory behavior has not been demonstrated. Seminole bats are thought to be resident within their range in the Deep South, remaining active throughout the winter when weather conditions permit (BCI website).

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Myotis austroriparius Southeastern Myotis (Jones and Manning, 1989)	Mostly aquatic insects	Maternity colonies form during late March and early April; parturition occurs from late April to end of May. 90% of pregnant females give birth to twins; 10% produce one young.	Females disperse from maternity colonies during October, though males depart earlier. In Florida, bats have both summer and winter roosts, but patterns of movement between sites are unknown. This species remains active throughout much of winter in the southern states.
Myotis grisescens Gray Myotis (Decher and Choate, 1995)	Mostly aquatic insects such as midges, beetles, mayflies, and caddisflies.	A single young is usually born to a pregnant female in early May, though parturition can occur as late as June.	Approximately 95% of the entire known total population hibernates in just nine caves each winter. Fewer than 5% of available caves are suitable as hibernacula for this species (BCI website). Summer roosts are more dispersed.
Myotis leibii Eastern Small-footed Myotis (Best and Jennings, 1997)	Mostly mosquitoes, small beetles, true bugs, and ants.	Maternity colonies form in the Spring. A single young is born to a pregnant female as early as May.	This species often arrives at hibernacula during mid November and leaves for summer roosts by March or early April. This species often remains active in its hibernacula, which are thought to be in close proximity to summer ranges.

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Myotis lucifugus Little Brown Bat (Fenton and Barclay, 1980)	Mostly aquatic insects, such as midges, mosquitoes, mayflies, and caddisflies; also beetles and moths.	Maternity colonies form in the spring (sometimes as early as March in the southern states). A pregnant female bears a single young as early as May.	Active bats use day and night roosts in the spring, summer, and fall; and may enter hibernacula as late as November in the southern states.
Myotis septentrionalis Northern Myotis (Caceres and Barclay, 2000)	Mostly flying insects, though will glean prey from substrates as well.	Parturition occurs between mid-May and mid-June. A pregnant female bears a single young.	Depending on latitude and environmental factors, hibernation may begin from September to early November and last until as late as May. This species will return to the same hibernacula though not necessarily in sequential seasons.
Myotis sodalis Indiana Myotis (Thomson, 1982)	Almost 90% of the diet of a pregnant female consists of soft-bodied insects like flies, moths, and caddisflies. Lactating females tend to prefer moths. By the end of the summer, the females eat beetles and leafhoppers.	Only a few maternity colonies have ever been found throughout this species' range. Females give birth to one young in June, though as late as July in some states.	In winter, the largest hibernating populations of this species occur in just three states: Kentucky, Missouri, and Indiana. Migration from winter roosts to summer roosts is usually northward to Indiana, Iowa, western Ohio, and southern Michigan. This species has a strong hibernacula fidelity.

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Nycticeius humeralis Evening Bat (Watkins, 1972)	Flying ants, spittle bugs, June beetles, Japanese beetles, and moths.	Usually two young are born to a pregnant female, though one to four young per litter is possible. Parturition in southern states like Florida, Alabama, and Louisiana occur from mid-May to mid-June.	Migration is highly suspected in northern populations of this species; yet, little is known about the exact migration movements. They seem to simply disappear from their summer habitat. This species is active throughout the year in Georgia, and Georgia is a likely winter destination for migrants of this species.
Pipistrellus subflavus Eastern Pipistrelle (Fujita and Kunz, 1984)	Mostly beetles, flies, mosquitoes, midges, ants, and moths.	In Spring, maternity roosts form. Each pregnant female usually bears two young during the last week of May or anytime during the first three weeks of June.	Winter and summer roosts are generally located at separate sites. Males and females will share winter hibernacula, usually found in caves, mines and other manmade structures. This species has demonstrated a strong roost fidelity, returning to the same summer roosts each year.

Ecology of Georgia Bat Species

Species	[1]Food Preferences	[1]Reproduction	[1]Migratory/ Hibernation Behavior
Tadarida brasiliensis Mexican Free-tailed Bat (Wilkins, 1989)	90% of diet consists of moths (primarily of the family *Gelechiidae*); many of the moth species are agricultural and forest pests.	Maternity colonies form in March; usually one young is born per pregnant female though twins and triplets have been recorded.	Bats of this species ranging eastward from eastern Texas do not migrate, though roost switching in an area may occur seasonally. Typically maternity colonies, if they disperse from a roost, will do so in September or October. This species has demonstrated strong roost fidelity, returning to the same summer roosts each year.

1. Information regarding Food Preferences, Reproduction, and Migratory/Hibernation Behavior was gathered from the Mammalian Species accounts for each species. The BCI website was also a source of information for this table.

[1]Georgia Bat Species and Bridge Roosting Potential

Species	Common Name	Potential Bridge Use	Roost Type Preference	Known Distribution in Georgia	[3]State Status
Corynorhinus rafinesquiiyes	Rafinesque's Big-eared Bat	Yes	Open Beam	Extreme northern region and southeastern region (along coastline)	Rare
Eptesicus fuscus	Big Brown Bat	[2]Yes	Crevice/ Open Beam	Statewide	-
Lasionycteris noctivagans	Silver-haired Bat	Yes	Crevice	Central and northern regions	-
Lasiurus borealis	Eastern Red Bat	No	-	Statewide	-
Lasiurus cinereus	Hoary Bat	No	-	Statewide	-
Lasiurus intermedius	Northern Yellow Bat	No	-	Southern and coastal regions	Not Listed; Considered Rare
Lasiurus seminolus	Seminole Bat	No	-	This species' distribution corresponds with that of Spanish moss in which these bats frequently roost; can be found statewide except in northern region.	-

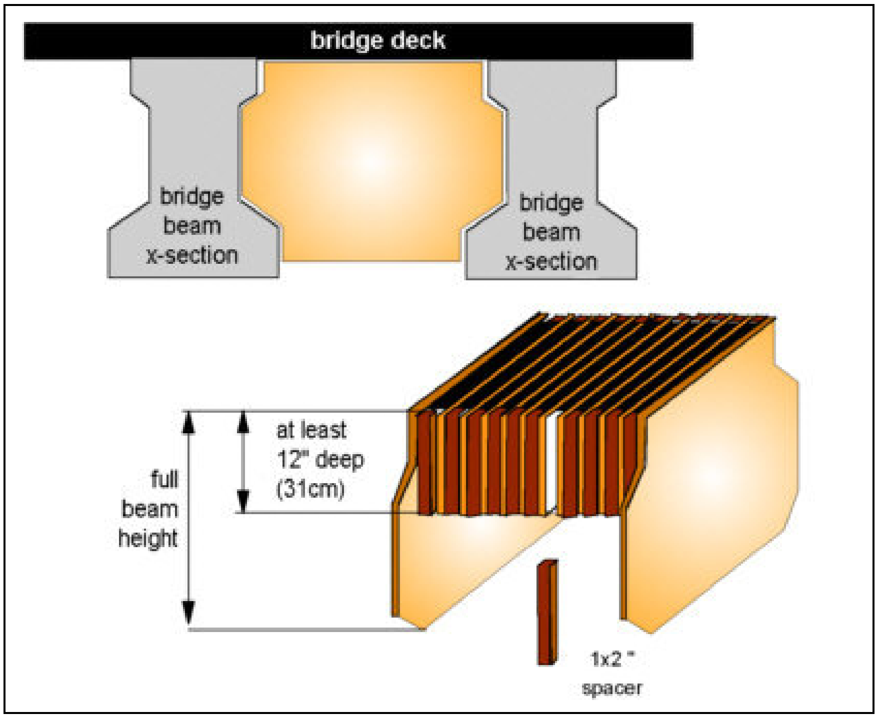
Myotis austroriparius	Southeastern Myotis	Yes	Crevice/ Open Beam	Statewide except portions of northern and western regions	Not Listed; Considered Rare
Myotis grisescens	Gray Myotis	Yes	Crevice	The first summer colony (4,000–9,000 individuals) from Georgia was reported approximately 15 years ago in a small limestone cave in Chattooga County (Martin and Sneed, 1990). This species has also been encountered in north Georgia and in western portion of the state.	Endangered (State & Federal)
Myotis leibii	Eastern Small-footed Myotis	Yes	Crevice	Northern region	Not Listed; Considered Imperiled because of Rarity
Myotis lucifugus	Little Brown Bat	[2]Yes	Crevice	Statewide	-
Myotis septentrionalis	Northern Myotis	Yes	Crevice	Primarily northern and western regions	-
Myotis sodalis	Indiana Myotis	Yes	Crevice	Extreme northern region	Endangered (State & Federal)

Nycticeius humeralis	Evening Bat	Yes	Crevice	Statewide	-
Pipistrellus subflavus	Eastern Pipistrelle	Yes	Open Beam	Statewide	-
Tadarida brasiliensis	Mexican Free-tailed Bat	[2]Yes	Crevice/ Open Beam	Statewide	-

1. Reference: List of species and state rank/status information provided by Greg Krakow (Data Manager), Georgia Department of Natural Resources, Wildlife Resources Division, Georgia Natural Heritage Program. Species use of bridges provided by Bat Conservation International and from observations in this study
2. Documented bridge use in this study
3. Definitions: Rare—A species that may not be endangered or threatened but that should be protected because of its scarcity; Endangered—A species that is in danger of extinction throughout all or part of its range; Not Listed, Considered Rare—Rare or uncommon in state (21 to 100 occurrences); Not listed, Considered Imperiled because of Rarity—Imperiled in state because of rarity (6 to 20 occurrences).

APPENDIX I. Construction Documentation and Drawings For Retrofitted Roost Habitats (Originally Published by Bat Conservation International in Bats in American Bridges, Resource Publication No. 4)

Figure 28. Texas Bat-Abode for crevice-dwelling species.



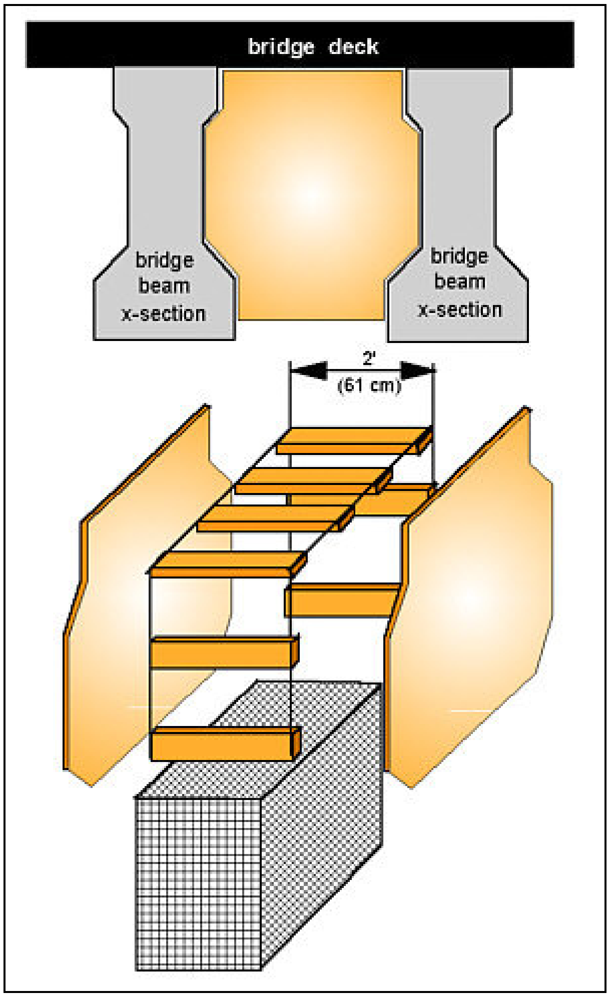
The Texas Bat-Abode is designed to retrofit bridges with bat habitat for crevice-dwelling species. It has an external panel on either side and 1x2-inch (2.5 to 5.1 cm) wooden spacers sandwiched between 0.5 to 0.75 inch (1.2 to 1.9 cm) plywood partitions (Figure 29). Recycled highway signs are ideal construction materials. Note that only the external panels need to be cut to fit the bridges' inter-beam spaces. The internal partitions should provide crevices 0.75 inch (1.9 cm) wide and at least 12 inches (31 cm) deep. Smooth roost surfaces need to be textured to provide footholds for bats on at least one side of each plywood partition (preferably both), creating irregularities at least every 1/8 inch (0.3 cm). Many methods have been tested to create footholds, such as:

- Using rough-sided paneling;
- Coating the panel with a thick layer of exterior polyurethane or epoxy paint sprinkled with rough grit;
- Attaching plastic mesh with silicone caulk or rust-resistant staples;
- Mechanically scarifying the wood with a sharp object such as a utility knife;
- Lightly grooving the wood with a saw (do not penetrate to the first plywood glue layer);
- Lightly sandblasting the wood with rough-grit.

The use of rough-sided paneling or polyurethane sprinkled with grit have provided the longest lasting results. Rust resistant wood screws should be used to assemble the spacers and partitions.

The Texas Bat-Abode should be installed in bridges that are at least 10 feet above ground, free of vegetation, and not susceptible to flooding or easy vandalism. Measurements of the exact location where the Bat-Abode is to be placed will ensure a proper fit. The number of partitions is arbitrary and limited only by availability of materials and support for the weight of the Abodes. Because of the weight, it might be easiest to assemble the cut pieces in the bridge. In wooden bridges, the unit should be anchored to the structure with heavy-duty rust-resistant lag-bolts.

Figure 29. Big-eared Bat-Abode



Big-eared bats are frequent bridge users in both the eastern and western United States. They prefer open roost areas such as cave entry rooms, large hollow trees, darkened undisturbed rooms in abandoned houses, or between the darkened beams of quiet bridges over streams. The Big-eared Bat-Abode creates these conditions.

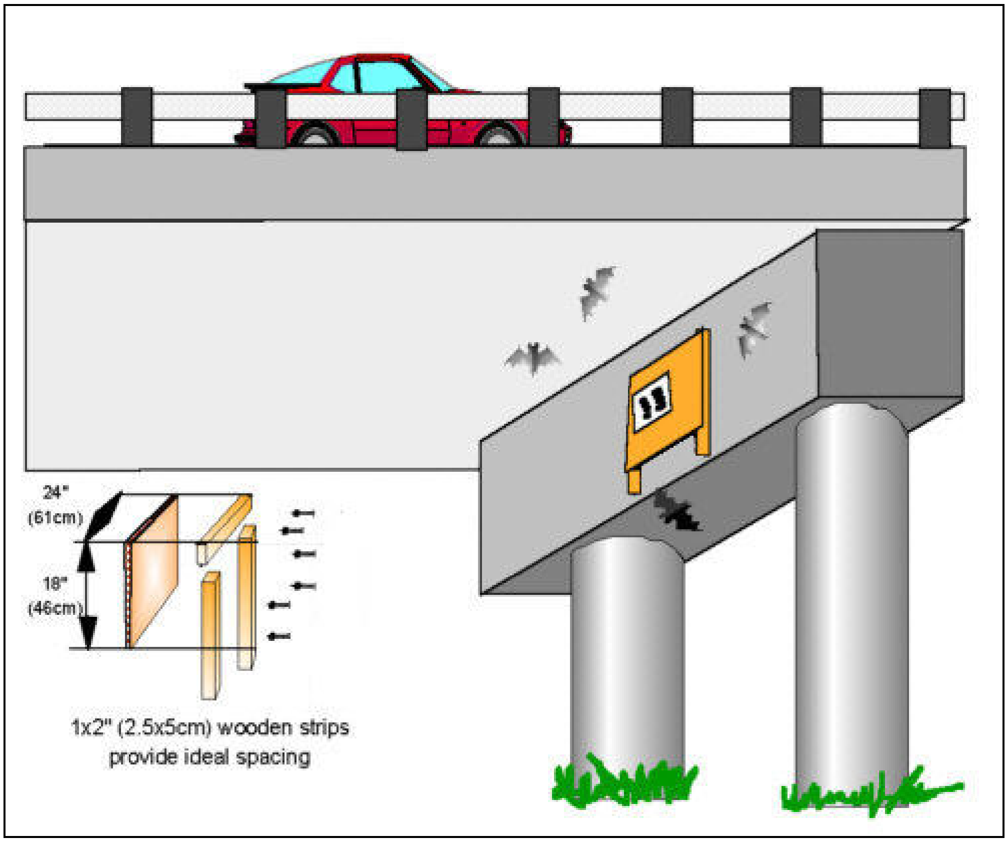
The Big-eared Bat-Abode has two external panels with 1x2-inch spacers that are used as braces to hold the panels together with a plastic mesh lining to provide footholds for bats. The netting should be attached using rust-resistant staples (Figure

30). The other methods of creating footholds mentioned above would also be effective.

It might be easier to partially assemble the structure on the ground leaving one end panel off until it is placed in its chosen location. Units installed in wooden bridges can be anchored using heavy-duty rust-resistance lag bolts. Because big-eared bats are very sensitive to disturbance, units should be placed in areas of low activity and painted a color that does not attract attention.

Big-eared bats are often found in low bridges darkened by thick vegetation growing along the sides. The Big-eared Bat-Abode should be placed at least 6 to 10 feet (2 to 3 m) above the ground in a secluded portion of the bridge. However, access to the fly-way entrance should not be blocked. Other bat species are also likely to use this structure.

Figure 30. Oregon Bridge Wedge. Designs courtesy of David Clayton and Dr. Steve Cross.



The Oregon Wedge is an inexpensive method of retrofitting bridges or culverts with day-roost habitat for bats. The Wedge is made from an 0.5 to 0.75 inch (1.2 to 2 cm) exterior grade plywood panel that is at least 18 inches high and 24 inches wide (46x61 cm) with three 1 x 2 inch (2.5x5 cm) wood strips attached along the top and sides, leaving an opening along the bottom. If larger panel sizes are used, vertical wooden pieces should be placed every 24 inches (61 cm) to support the plywood and prevent warping. The pieces should not run from the top to the bottom so that bats can move about within the panel.

The Wedge can be attached to a vertical concrete portion of a bridge or culvert using concrete anchor-bolts or a fast-drying environmentally safe epoxy cement (such as 3M Scotch coat 3-12). The transportation department should install the panels if anchor bolts are used. If the panel is to be attached to wood, then use appropriate rust resistant wood screws. Before applying the epoxy, check the preferred installation site to make sure the support strips fit flat against the concrete surface.

Wedge placement is possible on any adequately sized, flat concrete or wood surface. However, we recommend that the panels be placed near the sun-warmed road slab (preferably as high as possible between heat-trapping bridge beams). They should be at least 10 feet (3 m) above ground, with a clear flyway (at least 10 feet), and be out of view or reach of vandals. The Wedge can also be installed in the middle sections of culverts higher than 5 feet (1.5 cm). A Wedge should not be placed in structures that flood. As a precaution against flooding, a 1.5 inch (3.8 cm) gap can be left at each corner where the support strips join to act as an escape route in the event of fast-rising water.

Figure 31. Bat-domed culvert. Graphics courtesy of Texas Department of Transportation.

The Bat-domed culvert (Figure 32) is a modified concrete box culvert designed to accommodate large colonies of bats. The dome has several bat-friendly characteristics:

- The height is increased;
- Warm air is trapped;
- Light intensity is reduced;
- Air movement is reduced.

Bat-domed culverts should be at least 5 feet (1.5 m) in height with an additional 1 to 2-foot (0.6 meter) raised portion centered in the culvert. The raised area can be any length from 2 to 50 feet, depending on the colony size preferred. The walls and ceilings of the raised area should be roughened to provide footholds for bats. The following method was used to produce suitable wall and ceiling textures. Using a crowbar, thin strips were removed from the surface of recycled plywood. The resulting roughened wood was then used as the form for pouring the concrete, which produced the desired textured surface within the domed area of the culvert. In addition, a method of attaching panels or partitions, such as female threaded inserts, can be incorporated into the raised walls and ceiling to create more surface area once the culvert is completed.

Bat-domed culverts should not be placed in areas susceptible to flooding. However, in the event of rising water, the dome might serve as a temporary air-trap. Almost any cave-dwelling species might use these, including several that are endangered.